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# **THE ASSOCIATIONS BETWEEN SCHOOLCHILDREN'S FRUIT AND VEGETABLE INTAKE AND PSYCHOSOCIAL FACTORS**

– SHAPED BY GENDER,  
SOCIOECONOMIC BACKGROUND  
AND AN INTERVENTION

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ACADEMIC DISSERTATION

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# LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications:

- I Lehto Elviira, Ray Carola, Petrova Stefka, Krawinkel Michael, Behrendt Isabel, Papadaki Angeliki, Kristjansdottir Asa, Thorsdottir Inga, te Velde Saskia, Yngve Agneta, Lien Nanna, Lynch Christel, Vaz de Almeida Maria Daniel, Ribic Cirila Hlastan, Simčić Irena, Ehrenblad Bettina, Roos Eva: Parental educational level differences in mediators of fruit and vegetable intake among school children in ten European countries. *Public Health Nutrition* 2015, 18;89–99.
- II Lehto Elviira, Ray Carola, Haukkala Ari, Thorsdottir Inga, Yngve Agneta, Roos Eva: Do descriptive norms related to parents and friends predict fruit and vegetable intake similarly among 11-year-old girls and boys? *British Journal of Nutrition* 2016, 115;168–75.
- III Lehto Elviira, Ray Carola, Haukkala Ari, Thorsdottir Inga, Yngve Agneta, Roos Eva: Predicting gender differences in liking for vegetables and preference for a variety of vegetables among 11-year-old children. *Appetite* 2015, 95;285–292.
- IV Lehto Reetta, Määttä Suvi, Lehto Elviira, Ray Carola, Lien Nanna, Thorsdottir Inga, te Velde Saskia, Yngve Agneta, Roos Eva: The PRO GREENS intervention in Finnish school children - the degree of implementation impacts both mediators and the intake of fruits and vegetables. *British Journal of Nutrition* 2014, 112;1185–1194.

The publications are referred to in the text by their roman numerals.

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# **ABBREVIATIONS**

BMI Body Mass Index

CI Confidence Interval

EBRB Energy Balance Related Behaviour

FFQ Food Frequency Questionnaire

FV Fruit and Vegetable

PEL Parental Educational Level

SES Socioeconomic Status

## ABSTRACT

Low fruit and vegetable (FV) intake increases the risk for serious health problems which are common in post-industrial countries. Most children consume less FV than is recommended for a healthy diet and FV intake is especially low among boys and children with lower socioeconomic background. The already low childhood FV intake tends to decrease even further as children approach adolescence. Various environmental and psychosocial factors are known to have impact on FV intake. One of the most important determinants of children's FV intake is liking for FV, which has been found to be higher among girls than boys. Numerous interventions aiming to increase children's FV intake have been only moderately effective, which indicates that there are challenges in the implementation or that the relevant predictors of FV intake have not been targeted. The present study aims to address the gaps in knowledge regarding the mechanism behind the previously-documented associations. A more detailed view is gained by concentrating on the mediating factors of the associations between socioeconomic background and FV intake, gender and liking for vegetables and intervention effect on FV intake. Children's behaviour is influenced by her/his social environment, but it remains unknown whether descriptive norms related to friends are similarly important as those related to parents for children's FV intake.

The specific aims of the study were to clarify: 1) which factors mediate the association between parental educational level (PEL) and children's FV intake in ten European countries; 2) are the descriptive norms related to friends as important as those related to parents in determining children's FV intake and whether there are gender differences in the importance of these norms; 3) which environmental and psychosocial factors can explain gender differences in children's liking for vegetables; and 4) which environmental and psychosocial factors mediate the impact of a school-based intervention on children's FV intake and whether there are differences according to the implementation level of the intervention.

The study sample consisted of 11-year-old children, who participated in the PRO GREENS project. The data used in Study I was derived from ten European countries I (n=8159) whereas in Study IV the sample consisted of children in intervention and control schools (n=727) in Finland and Studies II and III included only children in control schools in Finland (n=424). Children answered

questionnaires assessing their FV intake frequency and several environmental and psychosocial factors at school in May 2009 and May 2010. Parents reported their highest level of education at the same time as they provided an informed consent for themselves and for their children. Teachers documented the implementation level of the intervention.

The results indicate that 1) in most studied countries, children with higher PEL were more likely to eat FV daily. Significant mediators for that association differed by country but the most important were higher availability of FV at home and children's higher knowledge of the recommendation among children with higher PEL. 2) Descriptive norms about FV intake among friends were as important as parental descriptive norms in predicting children's FV intake and were also better predictors of the change in FV intake than e.g. maternal descriptive norm. 3) Girls' higher liking for vegetables and greater variety in preferences was partly explained by girls' higher previous vegetable intake and fewer perceived barriers. In addition, girls' higher liking for vegetables was partly explained by higher parental demands to eat vegetables among girls. 4) The mediating factors in the group of higher implementation level were children's knowledge and liking for fruits whereas lower implementation level increased fruit intake via increasing the frequency children brought fruits to school for snacking. Higher implementation level of the intervention increased fruit intake more than lower level of implementation, whereas vegetable intake did not increase regardless of the implementation level.

In conclusion, when the aim is to increase children's FV intake and decrease associated gender and socioeconomic differences, one should try to have impact on schoolchildren's whole social environment including both parents and friends. Liking for FV and children's FV intake are intertwined, hence interventions should be implemented in high level and target them both. Special effort must be put to ascertain plentiful availability of FV and its consumption in a supportive environment, especially for boys and children with lower socioeconomic background.



# TIIVISTELMÄ

Vähäinen kasvisten, eli hedelmien ja vihannesten, kulutus lisää riskiä moniin vakaviin terveysoongelmiin, jotka ovat yleisiä jälkitekollisissa maissa. Useimmat lapset syövät ravitsemussuosituksia vähemmän kasviksia ja erityisen vähäistä kasvisten kulutus on pojilla ja alemman sosioekonomisen taustan lapsilla. Lapsuusiän vähäinen kasvisten kulutus alenee entisestään lasten lähestyessä nuoruusikää. Monilla ympäristötekijöillä sekä psykososiaalisilla tekijöillä tiedetään olevan vaikutusta lasten kasvisten syöntiin. Yksi tärkeimmistä kasvisten kulutusta ennustavista tekijöistä on kasviksista pitäminen, jonka on todettu olevan tytöillä yleisempää kuin pojilla. Lukuisat lasten kasvisten kulutusta lisäämään pyrkineet interventiot ovat osoittautuneet vain kohtalaisen tehokkaiksi, mikä voi johtua interventioiden täytäntöönpanon haasteellisuudesta tai siitä, että interventio ei ole kohdistunut kasvisten kulutuksen kannalta relevantimpiin tekijöihin. Tämä tutkimus pyrki selvittämään aiemmin havaittujen yhteyksien taustamekanismeja. Yksityiskohtaisempaa tietoa tarvitaan tekijöistä, jotka välittävät yhteyttä sosioekonomisen taustan ja kasvisten kulutuksen välillä tai jotka selittävät sukupuolieroja vihanneksista pitämisessä sekä niihin tekijöihin, joiden kautta interventio vaikuttaa kasvisten kulutukseen. Sosiaalisen ympäristön merkitys lapsen käytöstä määrittävänä tekijänä on suuri, mutta vähemmän tietoa on saatavilla siitä, vaikuttavatko ystäviin liittyvät deskriptiiviset eli kuvailevat normit lasten kasvisten kulutukseen samassa määrin kuin vanhempiin liittyvät.

Tarkemmin ilmaistuna tutkimuksen tavoitteina oli selvittää 1) mitkä tekijät välittävät vanhempien koulutustason yhteyttä lapsen kasvisten kulutukseen kymmenessä Euroopan maassa, 2) ovatko ystäviin liitetyt deskriptiiviset normit yhtä tärkeitä kuin vanhempiin liitetyt selitettäessä lasten kasvisten kulutusta ja onko normien vaikutus samankaltainen tytöillä ja pojilla, 3) mitkä ympäristötekijät ja psykososiaaliset tekijät voivat selittää sukupuolieroja lasten vihanneksista pitämisessä ja 4) mitkä ympäristötekijät ja psykososiaaliset tekijät välittävät kouluintervention vaikutusta lasten kasvisten kulutukseen ja eroavatko interventioryhmät toisistaan riippuen intervention toteutuksen voimakkuudesta.

Tutkimuksen otos koostui 11-vuotiaista lapsista, jotka osallistuivat PRO GREENS -projektiin. Osatutkimuksessa I käytettiin aineistoa kymmenestä Euroopan maasta (n=8159), osatutkimuksessa IV aineisto koostui Suomen

otoksen kontrolli- ja interventiokoulujen lapsista (n=727) sekä osatutkimuksissa II ja III ainoastaan kontrollikoulujen lapsista Suomessa (n=424). Lapset täyttivät koulussa toukokuussa 2009 ja 2010 lomakekyselyn, jolla mitattiin heidän kasvisten kulutuksensa frekvenssiä ja lukuisia siihen liittyviä ympäristötekijöitä ja psykososiaalisia tekijöitä. Vanhemmat ilmoittivat korkeimman saavutetun koulutusasteensa samalla lomakkeella kun antoivat suostumuksensa osallistua tutkimukseen sekä omasta että lapsensa puolesta. Opettajat raportoivat intervention täytäntöönpanoasteesta.

Tutkimustulokset osoittivat, että 1) suurimmassa osassa tutkimukseen osallistuneista maista lapset, joiden vanhemmilla oli korkeampi koulutustaso, söivät todennäköisemmin päivittäin kasviksia. Yhteyttä välittävät tekijät vaihtelivat maittain, mutta tärkeimmät välittävät tekijät olivat korkeammin koulutettujen vanhempien lasten korkeampi kasvisten saatavuus kotona ja lasten parempi tietämys saantisuosituksista. 2) Ystäviin liittyvät deskriptiiviset normit olivat yhtä tärkeitä kuin vanhempiin liittyvät deskriptiiviset normit lasten kasvisten kulutuksen selittäjinä ja ennustivat muutosta kasvisten kulutuksessa paremmin kuin esimerkiksi äitiin liittyvät deskriptiiviset normit. 3) Se, että tytöt pitivät enemmän vihanneksista ja suuremmasta valikoimasta vihanneksia kuin pojat, selittyi osittain tyttöjen runsaammalla, aiemmalla vihannesten kulutuksella ja harvemmilla koetuilla esteillä vihannesten kulutukselle. Tyttöjen suurempi vihanneksista pitäminen selittyi myös osittain sillä, että vanhemmat vaativat tyttöjä poikia useammin syömään vihanneksia. 4) Voimakkaamman täytäntöönpanon ryhmässä välittävinä tekijöinä olivat lasten lisääntynyt tietämys saantisuosituksista ja lisääntynyt pitäminen hedelmistä. Pienempi täytäntöönpanoaste sai lapset tuomaan useammin hedelmiä kouluun välipalaksi, mikä selitti intervention hedelmien kulutusta lisännyttä vaikutusta. Intervention voimakkaampi täytäntöönpano lisäsi lasten hedelmien kulutusta enemmän kuin interventio, joka oli toteutettu pienemmällä intensiteetillä. Vihannesten kulutus puolestaan ei lisääntynyt kummassakaan interventioryhmässä.

Kun tavoitteena on lisätä lasten kasvisten syöntiä ja vähentää siinä ilmeneviä sukupuolen ja sosioekonomisen taustan mukaisia eroja, tulisi kiinnittää huomiota lapsen sosiaaliseen ympäristöön, jossa sekä vanhemmilla että ystävillä on tärkeä rooli. Kasviksista pitäminen ja niiden syöminen ovat kiinteästi yhteydessä toisiinsa, joten interventiot tulisi panna täytäntöön voimallisesti ja kohdentaa sekä kasvisten kulutuksen että pitämisen lisäämiseen. Erityisesti poikien ja alemman sosioekonomisen taustan omaavien lasten kohdalla tulisi varmistaa kasvisten runsas saatavuus ja kulutus kannustavassa ilmapiirissä.

## ABSTRAKT

Lågt frukt- och grönsaksintag ökar risken för flera allvarliga hälsoproblem som är vanliga i post-industriella länder. De flesta barn konsumerar mindre frukt och grönsaker än vad som rekommenderas för en hälsosam kost, och frukt- och grönsaksintaget är speciellt lågt bland pojkar och bland barn med lägre socioekonomisk bakgrund. Det redan låga frukt- och grönsaksintaget i barndomen verkar minska ytterligare när barnen närmar sig tonåren. Många olika psykosociala och miljörelaterade faktorer är kända för att inverka på frukt- och grönsaksintaget. En av de viktigaste bestämningsfaktorerna för barns frukt- och grönsaksintag är det att man tycker om frukt och grönsaker, vilket har visat sig vara vanligare bland flickor än pojkar. En stor mängd interventioner vars syfte har varit att öka barns intag av frukt och grönsaker har haft endast en moderat effekt, vilket tyder på att det finns utmaningar i genomförandet av interventionerna eller att man inte lyckats nå de viktigaste bestämmande faktorer för frukt- och grönsaksintaget. Målsättningen i denna studie var att fylla de kunskapsluckor som finns om mekanismerna bakom de samband man tidigare har funnit. En klarare och mer detaljerad uppfattning om sambanden mellan socioekonomisk bakgrund och barns frukt- och grönsaksintag, mellan kön och att tycka om grönsaker samt mellan intervention och frukt- och grönsaksintag får man genom att undersöka vilka mellanliggande faktorer det finns i de nämnda sambanden. Barns beteende påverkas av den sociala miljön, men det är inte känt om deskriptiva normer som är relaterade till vänner, är på samma sätt viktiga för barns frukt- och grönsaksintag såsom de normer som relaterar till föräldrar.

De specifika målsättningarna för studien var att utreda 1) vilka faktorer är mellanliggande för sambanden mellan föräldrars utbildningsnivå och barns frukt- och grönsaksintag i tio Europeiska länder, 2) om deskriptiva normer relaterade till vänner är lika viktiga för barns frukt- och grönsaksintag som normer relaterade till föräldrar och om det finns könsskillnader i betydelsen av dessa normer, 3) vilka psykosociala och miljörelaterade faktorer som kan förklara könsskillnader i barns tycke för grönsaker, och 4) vilka psykosociala och miljörelaterade faktorer som medierar effekterna av en skolbaserad intervention på barns frukt- och grönsaksintag. Ytterligare undersöktes om graden av intervention ledde till skillnader i barnens frukt- och grönsaksintag och i de mellanliggande faktorerna.

Data för studien samlades från 11-åriga barn, som deltog i PRO GREENS projektet. Studie IV bestod av data från barn i tio Europeiska länder (n = 8159) och studie I bestod av data från finländska barn i intervention- och kontrollskolor (n = 727). Studierna II och III innehåller data endast från barn i kontrollskolorna i Finland (n = 424). Barnen rapporterade hur frekvent de åt frukt- och grönsaker samt svarade på frågor gällande psykosociala och miljörelaterade faktorer. Undersökningarna genomfördes under skoltid i skolan i maj år 2009 och 2010. Föräldrarna rapporterade sin högsta utbildningsnivå samtidigt som de gav ett informerat samtycke för sig själva och sina barn att delta i studien. Lärarna meddelade graden av genomförandet av interventionen.

Denna studie visade att 1) det var sannolikare att barn till föräldrar med högre utbildningsnivå konsumerade frukt och grönsaker dagligen. Detta gällde för de flesta länder som deltog i studien. Mellanliggande faktorer för detta samband skilde sig mellan länderna, men de viktigaste faktorerna var högre tillgänglighet av frukt och grönsaker hemma och en högre kunskap om rekommendationer bland barn vars föräldrar hade högre utbildningsnivå. 2) Deskriptiva normer för frukt- och grönsaksintag bland vänner förutspådde lika mycket frukt- och grönsaksintaget som föräldranormer. Vännernas normer var även en viktigare faktor att förutspå förändringar i barns frukt- och grönsaksintag jämfört med till exempel deskriptiva normer relaterade till mor. 3) Att flickor tyckte mera om grönsaker och om ett större urval av grönsaker kunde förklaras av flickornas tidigare högre grönsaksintag och färre upplevda hinder för att äta grönsaker. Flickornas högre tycke för grönsaker förklarades också delvis av föräldrarnas krav på att flickorna borde äta grönsaker. 4) I den interventionsgrupp vars grad av genomförandet var hög, ökade barnens fruktintag genom att barnens kunskap om frukt- och grönsaksrekommendationer steg och det att barnen började tycka mera om frukt. För interventionsgruppen där graden av interventionen var lägre, var den viktigaste mellanliggande faktorn det att barnen tog med sig mellanmålsfrukt till skolan. Om graden av interventionen var högre ökade också fruktintaget mera än när interventionen genomfördes till en lägre grad.

Då målsättningen är att öka barns intag av frukt och grönsaker samt att minska könsskillnader och socioekonomiska skillnader i intaget, är det viktigt att uppmärksamma skolbarnens hela sociala miljö, där både föräldrar och vänner har en viktig roll. Det att barnen tycker om frukt och grönsaker, och att de äter dem, är ihopkopplat och därför borde kraftfulla insatser riktas mot att både öka konsumtion och tycke. Särskilt då det gäller pojkar och barn med lägre socioekonomisk bakgrund borde speciell uppmärksamhet riktas mot att

säkerställa en riklig tillgänglighet till frukt och grönsaker samt en stödjande miljö för frukt- och grönsaksintag.

# 1 INTRODUCTION

Fruit and vegetable (FV) intake is a common subject in studies examining healthy diet practices. An adequate FV intake is recommended in order to prevent many common health problems in post-industrialized countries. In the adult population, high FV intake has been associated with lowered risk of weight gain (Buijsse et al. 2009), type two diabetes (Cooper et al. 2012), stroke (Hu et al. 2014), coronary heart disease (in western population but not in Asian) (Gan et al. 2015), and, in addition, modestly with cancer (Boffetta et al. 2010). Not only does the amount of FV eaten matter, but there are also benefits in consuming a wider variety of different sorts of FV for diabetes prevention (Cooper et al. 2012) and consuming specific subgroups of FV for coronary heart disease incidents (Bhupathiraju et al. 2013). The health problems outlined here tend to develop over a longer time frame, thus cannot be found among children. The studies examining the impact of FV intake on body mass index (BMI) among children have been unambiguous, but some longitudinal studies have found low FV intake to predict overweight also among children (Jong et al. 2014, Ledoux et al. 2011). In addition to the long-term positive effects, the importance of an adequate FV intake in childhood is due to the stability of eating patterns: high FV intake established in childhood, is likely to track into adulthood (Lien et al. 2001, Lipsky et al. 2015, Te Velde et al. 2007).

Most children fall short of the recommendations for an adequate amount of FV needed for a healthy diet (Lynch et al. 2014) and a large proportion of children do not eat FV even daily (Yngve et al. 2005). It is also a common pattern that already low FV intake among children decreases even further when children approach adolescence (Vereecken et al. 2015). Low FV intake has been reported to be more common among children with lower socioeconomic background meaning that low parental education, income or occupation are associated with children's risk to consume an inadequate amount of FV (Rasmussen et al. 2006). In addition to socioeconomic background, gender has been identified as an important determinant for low FV intake level (Vereecken et al. 2015). Girls' higher FV intake, compared to boys', is not necessarily notable among smaller children but gender differences in FV intake develop while children grow older.

Among children, it is obvious that parents play a crucial role in formation of the food environment in which FV intake is both possible and desirable for the child. Hence children's higher FV intake has been repeatedly associated with

higher availability of FV at home, parents' own FV intake which serves as a role model for the child and parents' verbal encouragement (Pearson et al. 2009a). To be willing to eat a sufficient amount of FV, children also have to like the taste of FV. Parents have a great impact in the development of children's positive taste preferences since a child learns to like, for example, a certain vegetable by tasting it repeatedly several times (Ventura and Worobey 2013). With increasing age, friends and peers strengthen their impact on children's thoughts and behaviour, FV intake being no exception (Houldcroft et al. 2014). There are also other, psychological and social, factors which affect FV intake among children. Children are more likely to consume FV if they have trust in their own capabilities to do so, i.e. have high self-efficacy, or if they possess the knowledge about how much FV are recommended in order to have a healthy diet (Rasmussen et al. 2006). Still, most of the eating behaviour, especially among children, is not based on careful consideration and conscious decisions each time one acts, but it is conducted based on one's habits. Neither gender nor socioeconomic background are determinants of FV intake per se, but other factors define what is possible and desirable for a member of that certain group.

Since low FV intake has been recognized as a severe problem for public health, numerous campaigns and interventions have sought to increase children's FV intake, but most of have yielded a moderate effect at best (Evans et al. 2012). The present doctoral thesis aims to increase the knowledge about the environmental and psychosocial factors which are crucial for increasing children's FV intake, and in the best instance, also could decrease gender and socioeconomic status (SES) differences in FV intake. This thesis consists of four studies, each concentrating on some aspects which have been identified as significant associates of FV intake. These studies either try to clarify the mechanism behind the associations, or adjust the effect in comparison with other factors. This body of work is part of the PRO GREENS project, which aimed at increasing 11-year old children's FV intake in ten European countries. PRO GREENS was developed from a previous European level project Pro Children, from which the conceptual model is presented in Figure 1. With an exception of one study which examines the SES differences in FV intake on a European level, the other three studies assess the impact of gender, an intervention and children's social environment on FV intake or liking for FV among Finnish children. The aims of the study and specific study questions are described in more detail in chapter three. First, the relevant knowledge gained from previously published research is presented here in a review of the literature (chapter two).

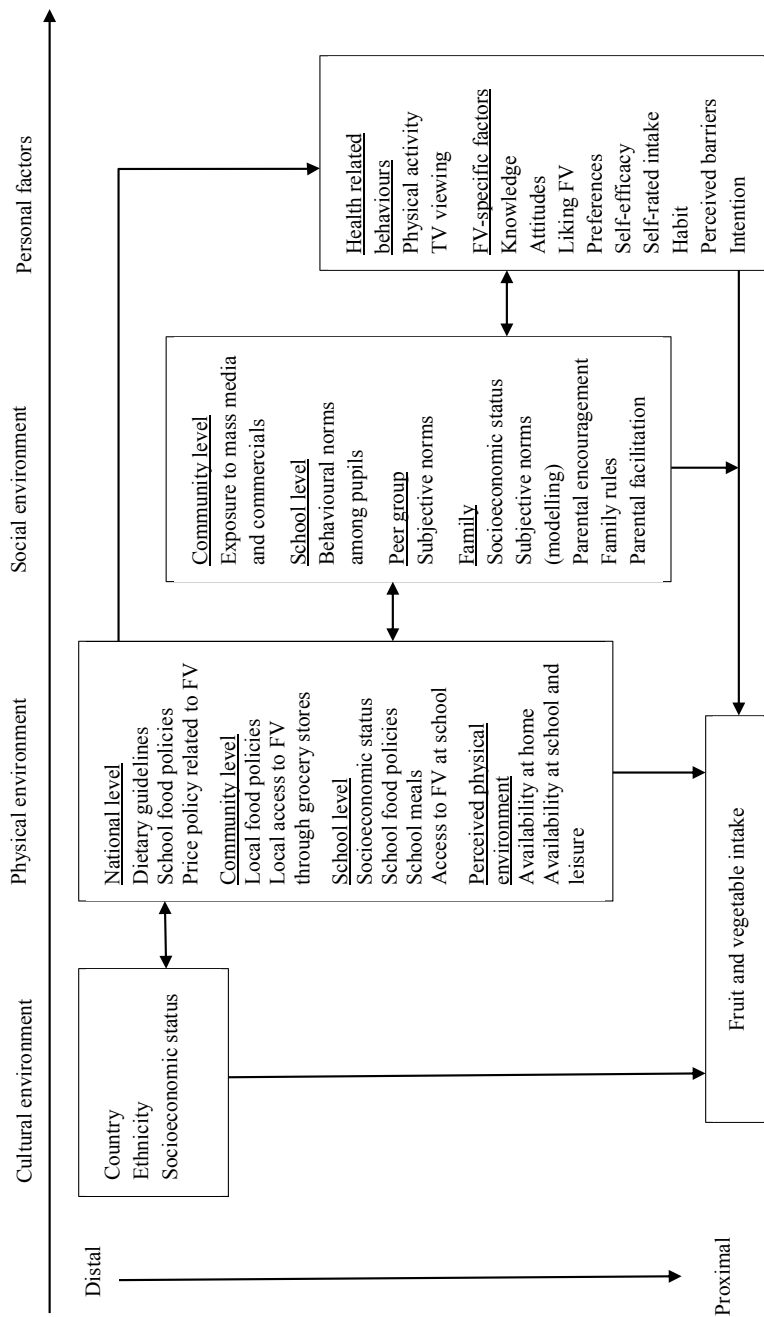


FIGURE 1. Modified socio-ecological model explaining children's FV intake as presented by Klepp et al. (2005) originally for the predecessor of the PRO GREENS project.



## 2 REVIEW OF THE LITERATURE

The present study concentrates on the environmental and psychosocial factors that are associated with children's FV intake and, moreover, on gender and socioeconomic differences in these associations. The key concepts are FV intake, socioeconomic background, gender, preferences for FV as well as psychosocial factors. Furthermore, the role of psychosocial factors in explaining the intervention effect on children's FV intake is discussed.

### 2.1 FRUIT AND VEGETABLE INTAKE

When FV intake is used as a measure of health behaviour or as an indicator of a healthy diet, FV is often defined as including all kinds of fruits, berries and vegetables. They can be fresh, raw, cooked or prepared in some other way. Fruit intake is identified as 'intake of fresh fruits' in most cases, to be sure to exclude the intake of canned fruits, which have a high proportion of added sugar. Similarly, fruit juice is not included in the definition of FV in most studies due to its high concentration of sugar in relation to its lack of fibre. In addition, potatoes are usually excluded from the definition of FV due to their high starch content.

The World Health Organization (WHO) recommends at least 400 grams of FV per day (World Health Organization 2003). The amount of 400 grams is pictured as an equal to five portions, where one portion is a generous handful of fruits or vegetables. In Finland the current recommendation for the daily FV intake is at least 500 grams of fruits and vegetables (The National Nutrition Council 2014). These abovementioned recommendations are directed to the adult population and the adequate daily amount of FV for children is dependent on their age and size. For children the recommendations can be adjusted better with the portion example: the smaller the child is, the smaller is her/his hand and thus the smaller the required size of the portion. Due to the body size and energy requirements of 11- to 12-year old children, who comprise the study population of this thesis, the recommended level of daily FV intake for children can be set near to the recommendations for adults or at least to 400 grams.

Most children in Europe do not meet the recommendations concerning daily FV

intake (Jones et al. 2010, Lynch et al. 2014). The mean FV intake in ten studied countries was 263 grams and 23.5% of the children reached the recommendations (Lynch et al. 2014). In Finland only 13.8% of children ate at least 400 grams of fruits and vegetables daily, where the mean FV intake was 231 grams among girls and 209 grams among boys (Lynch et al. 2014). The already low FV intake diminishes even further when children approach adolescence (Vereecken et al. 2015) and during adolescence (Larson et al. 2007). As noted in a study conducted in ten European countries (Diethelm et al. 2012), adolescents eat only half of the recommended amount of fruits and vegetables. Some encouraging changes on a European level have been reported: the prevalence of daily FV intake has increased during the last decade among both girls and boys in the age groups of 11-, 13- and 15-years (Vereecken et al. 2015). Still, not all studies have reported a similar change: FV intake has stayed stable in France (Lioret et al. 2010) and in Lithuania fruit intake has increased among girls and vegetable intake decreased among boys (Zaborskis et al. 2012). Among Finnish children no recent studies have been published about the trends in FV intake or in SES gradient in FV intake. During the last decade in Norway, the general trend in daily FV intake prevalence among children has been positive but, nevertheless, the improvement has not diminished the socioeconomic differences in FV intake (Fismen et al. 2014).

The reasons behind inadequate FV intake can vary and there is a long and ample study tradition examining the predictors and associates of FV intake. It must be borne in mind that the importance of environmental and psychosocial determinants is likely to differ somewhat between children and adults due to their dissimilar levels of autonomy and skills. Children are more dependent on their social environment and interaction with parents and probably less capable of diverse reasoned and consequent modification of behaviour. Eating behaviour is by no means an automatic response to cues, thus children's FV intake and its associates have also been studied in relation to theories such as Social Cognitive Theory (Bandura 1986), Theory of Planned Behaviour (Ajzen 1991), or Attitude–Social influence–Self-efficacy-model (Kok et al. 1996). Since this thesis neither aims to verify nor is based on a certain theory, theoretical backgrounds are only presented if the referred studies have explicitly tested a theory or when the main concepts of the thesis are first introduced. In the next sections, the factors that have been consistently associated with children's FV intake and are relevant for the present study are presented.

## 2.2 FRUIT AND VEGETABLE INTAKE AND ENVIRONMENTAL FACTORS

To have FV available and accessible is of course the most important prerequisite for anyone to be able to eat FV. Hence availability of FV at home has been consistently associated with children's FV intake (Rasmussen et al. 2006, Pearson et al. 2009a, Blanchette and Brug 2005). Some variation has been noted since, for example, among 15-year-olds in the United States, home availability of FV correlated only with FV intake of girls but not of boys (Hanson et al. 2005). Moreover, it seems that it can be children's own perception of the availability, and not the one of parents, which is more likely to be related to children's FV intake (Cook et al. 2015, Kristjansdottir et al. 2009). A similar finding was reported in a Norwegian study: parents' views of accessibility (a concept combining aspects of availability and parental facilitation) of FV at home was more positive than that of their child, but was not as strongly associated with children's FV intake as children's own perception of accessibility (Bere and Klepp 2004). Parents are likely to have more accurate knowledge of the availability of FV at home since they are probably purchasing FV but, on the other hand, one cannot rule out the possibility that the reporting by parents is biased due to socially-desirable responding. The results can be interpreted to express the fact that it is not necessarily the objective circumstances but a person's interpretation of the situation which determines one's response to it. This means that the mere presence of FV in the children's environment is not necessarily a sufficient stimulus to achieve FV consumption, but some psychosocial processes need to take place in order to trigger the eating behaviour. Few studies, however, have examined the causal chain linking availability and FV intake. In the Netherlands, parental perception of food shopping environment (e.g. price, quality and availability of FV in the shops) had an effect on fruit but not on vegetable availability at home (van Ansem et al. 2013). In a Pro Children study, home availability of fruits was significantly associated with children's fruit intake in all examined nine European countries (Wind et al. 2010). The mediators differed somewhat between the countries, but liking for fruits and self-efficacy to eat fruits were identified as the strongest factors explaining the association between home fruit availability and children's fruit intake (Wind et al. 2010). It has also been noted in a study using the same data as the above-mentioned study that when several psychosocial factors were examined simultaneously, availability was not associated with children's daily fruit intake in any of the nine countries and home vegetable availability was associated with children's vegetable intake only in one country (De Bourdeaudhuij et al. 2008).

Since children spend a considerable amount of time outside home, the availability of FV at schools or after school clubs, for example, could be supposed to contribute to children's FV intake as well. There are, however, fewer studies that have examined the impact of FV availability outside the home environment on children's FV intake. In a European sample, similar to home availability, neither FV availability at school nor at friend's houses was associated with children's FV intake, probably due to different psychosocial factors in the same model (De Bourdeaudhuij et al. 2008). In Finnish schools, a free school lunch, which always includes grated vegetables or salad but seldom fruits, is served on all school days. Still, it has been reported that among 13–15-year olds only 39 percent of boys and 56 percent of girls had eaten the salad part of the school lunch in the study week (Tikkanen and Urho 2009). When asked whether the 13-year olds usually eat salad on school lunch, approximately 85 percent of girls and approximately 70 percent of boys responded positively (Hoppu et al. 2010). In addition, school lunch is only one of the daily eating occasions, which is supposed to provide children with one third of the daily energy (The National Nutrition Council 2008). Therefore, it is clear that children cannot compensate the lack in home FV availability solely with the vegetables served at school lunch. FV intake among Finnish children has indeed been found to be lower than among children from countries in which the school lunch is not provided (Lynch et al. 2014). Still, there can be simple arrangements in the availability that can affect children's FV intake. Among schoolchildren in the United States, when fruits were served as dessert and not together with vegetables as part of the meal, a larger proportion of children ate vegetables even though no differences were found in liking for vegetables (Zellner and Cobuzzi 2016).

Besides the observable amount of FV available at home or at school, children's environment can be formed by the family structure. The size of the family, however, has not been associated with children's FV intake in a review by Rasmussen et al. (2006). It has to be noted that the reviewed studies were conducted in the 1980s or outside Europe, which means that the results are not necessarily applicable to present Europe. Having more siblings has been associated with a smaller variety in vegetables eaten by children as young as six months (Koh et al. 2014). In addition to family structure, family SES can be regarded as an environmental factor. Family SES is, however, not included in this section but discussed in more detail later, since it is more likely to affect behaviour via other factors. Similar to SES, with many other factors related to human behaviour, a firm distinction between environmental and psychosocial is nearly impossible to make. The division made in the present thesis is of practical

nature and aims to draw the attention to the multidimensionality of psychosocial factors, which are presented next.

## 2.3 FRUIT AND VEGETABLE INTAKE AND PSYCHOSOCIAL FACTORS

‘Psychosocial’ is a term defined to be the combination of psychological and social factors. This means that even though certain behaviour, such as parental verbal encouragement, is a social act from the parental side, it also contains the psychological aspects since the message and the act are interpreted by the recipient child. Hence, when the focus is on explaining children’s behaviour, it is meaningful to label encouragement as a psychosocial construct. Due to the complex nature of interaction, it is impossible to firmly set boundaries to determine when some factors are categorized as psychological, social, psychosocial or social environmental. Although factors such as knowledge would most likely be categorized as psychological or personal, for the sake of clarity, throughout the text in the current thesis the term psychosocial is used for all other than environmental factors.

### **Descriptive and prescriptive norms**

Observing the behaviour of others is an important psychosocial factor that influences human behaviour. Albert Bandura (1986) has proposed in his Social Cognitive Theory that children learn to behave in a certain way by observing their parents’ or caretakers’ behaviour. The perception of certain behaviour, and a thought which is postulated to be found behind the act, can with other words be called a descriptive norm (sometimes also referred to as subjective norm). Descriptive norm is simply a recognition of what is thought to be typically done by others, often by the members of the group which one somehow identifies her/himself with. A descriptive norm differs from a prescriptive norm (sometimes also called an injunctive norm), which more specifically tells what – again according to one’s own perception – other people typically think one should and should not do, and what these people do or do not value. According to Social Cognitive Theory, one is more interested in engaging in behaviour according to norms when the modelled persons are significant or they are seen to be similar to oneself (Bandura 1986).

Parental FV intake has been reported to be one of the strongest associations

with children's own FV intake (McClain et al. 2009). In a longitudinal Australian study, baseline descriptive norms related to mothers' fruit intake preceded children's fruit intake two years later, whereas no effect was found for vegetable intake (Pearson et al. 2011). The results have been, however, somewhat inconsistent depending on who has reported the parental FV intake and whether the modelled parent is of the same gender as the child. Among Icelandic children, for example, FV intake was associated with maternal FV intake reported by mothers but not with maternal FV intake reported by children (Kristjansdottir et al. 2009). This is in contrast with a Norwegian study among similarly aged children whose FV intake was associated with parental FV intake, whether it was reported by parents themselves or if it was the children's perception of parental FV intake (Bere and Klepp 2004). There are inconsistent findings for gender differences regarding parental role models for child FV intake. Some studies have found no gender differences in perceived maternal FV intake (Kristjansdottir et al. 2009) or in parental modelling for FV intake (Pearson et al. 2009b). Among Finnish children, reported by parents, FV intake of mothers was associated both with girls' and boys' FV intake, whereas fathers' FV intake correlated only with FV intake among boys (Talvia et al. 2006). There might also be a period in adolescence when parents are not the most favoured role models. This was suggested by a study conducted in the United States, in which parental FV intake reported by parents predicted 16-year-old adolescents' FV intake in the follow-up when the participants were 21-years (Arcan et al. 2007). A similar effect was not found for those who were 12-years old at baseline and 17-years old in the follow-up (Arcan et al. 2007).

Children spend lot of time with peers and friends at school and mostly also share daily meals with them. Therefore, it is likely that children's eating behaviour is also influenced by friends and peers (Houldcroft et al. 2014). Peers are persons of a similar age and/or developmental level as the child, but to whom the child is not equally emotionally attached to as to friends or family members. When approaching adolescence, the peers' impact on children is thought to become stronger along with superseding the parental impact. That is a slow and individually-differing process and the time frame for such development is therefore unambiguous. Among 12-year olds, parental descriptive norms have been shown to be stronger associates of children's FV intake than those related to their peers (Pedersen et al. 2015). Prescriptive norms, however, whether they were related to parents or peers, were not associated with children's FV intake when they were included in the same model with descriptive norms (Pedersen et al. 2015). Among 16-17-year-old Brits, peer descriptive norms explained 22 percent of the variance of adolescents' usual FV intake frequency (Lally et al.

2011). The actual peer FV intake (reported by the peers by themselves), however, was not associated with adolescents' FV intake. This is unfortunate, since the actual FV intake of peers was significantly higher than the under-estimating descriptive norms related to peers' FV intake (Lally et al. 2011). An experimental study with 15-year-olds demonstrated that descriptive norms related to peer fruit intake yielded an increased fruit intake (Stok et al. 2014). Prescriptive norms, on the contrary, were not only non-significant predictors of actual fruit intake but negatively affected adolescents' intention to consume fruits (Stok et al. 2014). This kind of reactance to prescriptive norms might appear, since adolescents do not necessarily like to be told what they should do. On the other hand, Pedersen et al. (2015) hypothesized that the negative correlation between prescriptive norms and children's FV intake can be attributed to a real life situation where only those with low FV intake think that others would perceive their FV intake to be low as well, and therefore attribute to them the opinion that their low FV intake should be increased.

### **Encouragement and demand**

In addition to being a role model, parents often try to get their children to increase FV intake by verbally encouraging or demanding them to eat FV. There is much diversity in the terminology used in the literature regarding factors associated with children's FV intake. Prescriptive norms, for example, are not always completely distinct from children's perception of parental rules, demands or encouragement aiming to get the child to eat more FV. It is likely that children, who report that there are rules at home about eating FV in every meal or that their parents demand them to eat FV every day, would as well postulate these actions to be due to parental thoughts that they want their children to eat FV. Sometimes separate constructs are combined and appear under a different name as has been in the study of Melbye et al. (2012): parental influence, a construct including both parental descriptive norms and verbal encouragement, was found to be associated with FV intake among Norwegian schoolchildren. Still, parental encouragement alone has been associated with higher FV intake among 6- to 11-year old children in several reviewed studies (Pearson et al. 2009a). On the other hand, among Icelandic schoolchildren, children's own perception of their mother encouraging them to eat FV was not associated with their FV intake (Kristjansdottir et al. 2009). Still, more encouragement reported by mothers was associated with less frequent vegetable intake, which can be interpreted to be the result of low vegetable intake rather than the other way around. Interestingly, in the same study, a demanding family rule was associated with higher FV intake among children if demand was

reported by children but with parental report of demand no association was found. (Kristjansdottir et al. 2009.)

### **Self-efficacy**

Self-efficacy is a central concept in Bandura's Social Cognitive Theory and can be defined as one's perception or belief that one is capable of completing a certain act. Self-efficacy originates mainly from previous own experiences and vicarious experiences, but can be formed by social feedback received from significant others and the perception and interpretation of own physiological responses to a situation (Bandura 1977). Since general self-efficacy is a mental construct, it is not always in accordance with objectively-measured capabilities and skills of a person. This means that a similar situation can be interpreted to be hard to handle by a person with low self-efficacy or as easy to manage by a person with high self-efficacy. Self-efficacy, or 'perceived competence' as it is defined in Self-Determination Theory developed by Ryan and Deci, plays an important role in the formation of intrinsic motivation (Ryan and Deci 2000). In addition, Ajzen's Theory of Planned Behaviour (Ajzen 1991) operates with perceived behavioural control, which is a concept closely related to self-efficacy.

Even though self-efficacy is theorised to be needed both for the formation of intention (Ajzen 1991) or in bridging the intention-behaviour gap (Sniehotta et al. 2005), in studies conducted among children it is often used as a direct associate of FV intake. Children's FV intake has often been associated with their self-efficacy to eat FV or make the consumption of FV possible, although the association has not been significant in all reviewed studies (Rasmussen et al. 2006, Blanchette and Brug 2005). An Australian study among children who were 7-years at baseline, found that those with high self-efficacy were more likely to have increased their FV intake two years later (Pearson et al. 2011). Among Dutch children, self-efficacy has been found to be more strongly related to girls' fruit intake but to be equally important for both genders for vegetable intake (Reinaerts et al. 2007). It can be hypothesized that self-efficacy becomes more important when children grow older and become more and more responsible for their own food. With increasing age, the amount of previous experiences needed for the formation of self-efficacy is cumulating and the boundaries set by the environment become clearer. Hence, self-efficacy has been found to act as a mediator between home fruit availability and children's fruit intake (Wind et al. 2010) or between parental feeding practices and children's vegetable intake (Melbye et al. 2013). The latter study demonstrated that parental restrictions for unhealthy food were negatively associated both with



children's own self-efficacy and vegetable intake, whereas high self-efficacy was associated with higher vegetable intake (Melbye et al. 2013).

## **Attitudes**

Attitudes can be defined as a person's valuating thoughts about something, for example, whether eating FV is good or bad, important or not important. Instead of 'attitudes', in some studies a similar construct is called 'outcome expectancies', which stresses somewhat more the future perspective – what is the expected outcome of the behaviour. In such cases, participants could have been asked to indicate their agreement to statements like "Eating FV gives me more energy". People often think that their actions are congruent with their attitudes, albeit research has shown that there is often a non-correspondence, which is called the "attitude-behaviour gap". One factor narrowing the gap is intention, a concept more proximal to behaviour than attitudes (Ajzen 1991). Theory of Planned Behaviour suggests that for the formation of intentions, the following constructs are needed; attitudes, subjective norms and perceived behavioural control (behaviour-specific self-efficacy) (Ajzen 1991). It can be assumed that the younger children are, the less capable they are to form intentions and behave accordingly. Among schoolchildren, however, there are already numerous studies which have examined the associations between attitudes and FV intake.

Rasmussen et al. (2006) reported children's positive attitudes about FV to be associated with higher FV intake in all of three papers included in the review. In contrary, attitudes were related to children's FV intake only in one out of nine European countries (De Bourdeaudhuij et al. 2008). In the whole sample, attitudes were significantly associated with FV intake together with factors such as liking for FV and descriptive norms (De Bourdeaudhuij et al. 2008). Attitudes have been associated with both fruit and vegetable intake among 4–12-year-old Dutch children, but become non-significant for fruit intake when environmental factors such as availability or parental descriptive norms are added to the model (Reinaerts et al. 2007). Somewhat similar results were derived from 11-year-old children in Norway where attitudes correlated with both fruit and vegetable intake: However, when included in the regression model with intention, self-efficacy, parental encouragement and descriptive norms, attitudes did not contribute to the explanation of FV intake (Melbye et al. 2012). The study results were in line with the ASE-model since attitudes – together with self-efficacy, parental encouragement and descriptive norms – contributed significantly to the explanation of children's intention to eat FV (Melbye et al. 2012).

## **Barriers to eating fruits and vegetables**

There can be several psychosocial, perceived barriers that hinder children from eating an adequate amount of FV. The term barriers is used ambiguously in different studies but mainly it aims to capture aspects such as children's negative views of the outcomes of eating FV, desire to eat something else instead of FV, or perception that eating FV intake is unpleasant since one gets sticky hands or one does not get full from eating FV. Many questions measuring barriers among children could also be categorized under the specific labels: 'attitudes' or 'outcome expectancies'. Children are likely to perceive different things to be barriers for eating FV compared to adults. Parents of primary-school children have named, for example, lack of time to prepare food that includes vegetables or the high price of fruits to be barriers for their FV intake (Glasson et al. 2011). Little attention has been given to examining barriers for children's FV intake, in contrast to the greater amount of literature for adults. In addition, due to the vagueness of the definition, most studies have preferred the terminology like 'negative outcome expectancies' or 'negative attitudes'. One of the few studies which has operated with the construct perceived barriers was the Pro Children study, which served as a foundation for the PRO GREENS project. No association between perceived barriers and children's FV intake was evident for the nine European countries which participated in Pro Children (De Bourdeaudhuij et al. 2008). The gender-specific analyses in Iceland, however, showed that perceived barriers were associated with fruit intake among girls but not among boys (Kristjansdottir et al. 2006).

## **Knowledge of the recommendations for a healthy diet**

Children's knowledge of the recommended amount of FV that is needed for a healthy diet has been found to be associated with children's FV intake, although not consistently (Blanchette and Brug 2005). The discrepancy of the results is thought to be due to the differences in the conceptualization of the knowledge. On the other hand, the knowledge can be of unequal importance for children's FV intake in different countries. De Bourdeaudhuij et al. (2008) reported knowledge to be associated with children's fruit intake in all examined nine countries, but for vegetable intake the association was found in five out of nine countries. A change in children's knowledge of the recommendations significantly contributed to the explanation of the change in children's FV intake, even when accessibility and preferences were included in the same model (Bere and Klepp 2005). Taking into account the fact that availability/accessibility and preferences are some of the strongest predictors of children's FV intake (Rasmussen et al. 2006), the significance of knowledge in

the same model stresses its importance. On the other hand, it can be hypothesized that the individual predicting power of knowledge might also be attributed to its dissimilarity to, for example, constructs measuring social influence which have high inter-correlations and thus can lose their predictive power in the models where all factors are included at the same time.

## **Preferences**

It is reasonable to assume that children are more likely to rely solely on immediately-reachable pleasures, such as good taste, than to care for long-term health benefits when deciding whether they would eat a certain food or not. Thus, liking for FV is one of the most important associates and predictors of FV intake among children (Blanchette and Brug 2005, Rasmussen et al. 2006). Liking the taste of FV can be seen as a necessary, but not as a sufficient prerequisite for eating FV. A study conducted among adolescents in the United States reported an interaction between liking for FV and home FV availability when explaining FV intake (Neumark-Sztainer et al. 2003). Adolescents' FV intake was high when FV were available at home, even though adolescent's liking for FV was low. Similarly, when FV availability was low, FV intake level was the same among all adolescents, regardless of their liking for FV. This can be interpreted to show the necessity of FV availability not only for FV intake but also for the impact of liking on FV intake to be realized. (Neumark-Sztainer et al. 2003.)

It is also important that one likes and thus consumes a wider variety of FV since it is unlikely that someone who only likes and consumes only a very limited variety of FV can reach the recommended level of FV intake. Moreover, not only the absolute amount of consumed FV has health outcomes, but consuming a wider variety of different kinds of FV, or a certain sub group such as green leafy vegetables, is associated with health benefits (Bhupathiraju et al. 2013, Cooper et al. 2012). In a study by Sandvik et al. (2010), a variety in fruit preferences was not associated with children's fruit intake in low, middle or high SES groups. Such lack of association is understandable in the case of fruits, since fruits are generally well liked among children and therefore it is easier to eat enough fruits even when not so many sorts of fruits are liked. It can be hypothesized that in the case of vegetables, the recommendations would be harder to reach when the variety of preferences is very limited. On the contrary, Kristjansdottir et al. (2006) found a significant association between preferences for a variety of FV and both children's fruit intake and vegetable intake. These associations have proven strong, despite a variable which measured children's liking for FV in the

same model (Kristjansdottir et al. 2006).

Given the importance of liking for children's FV intake, many interventions have aimed at increasing liking, and thus children's FV intake. A Dutch study (Tak et al. 2008) noted that increased liking for FV predicted higher FV intake only after the first intervention year but the effect became non-significant after the second year. The association seemed to be stronger in reverse: increased or stable high FV intake predicted children's higher liking for FV even two years after the intervention (Tak et al. 2008). These findings do not solely demonstrate the strong relation between FV liking and intake, but also stress the importance of FV intake in the formation of taste preferences.

## 2.4 PREFERENCES AND THEIR PREDICTORS

It is generally believed that people, as a result of evolution, have an innate preference for sweet and fatty tastes and an aversion to bitter tastes. This is hypothesized to have been beneficial in securing human beings with enough energy that is mostly characterized by sweet and fatty tastes and in avoiding toxics, which often taste bitter. In addition to toxins, however, many vegetables are also characterized by, at least minor, bitter taste. Still, there is a genetic variation in the ability to taste bitterness that is suggested to have an influence on children's willingness to eat vegetables (Negri et al. 2012). A study examining the associations between children's liking for vegetables and their sensitivity to bitter taste, which is established in both their genotype and phenotype, found no association (Feeney et al. 2014). In that study, the only factors that correlated with children's liking for vegetables were gender and socioeconomic background (Feeney et al. 2014).

Even with a moderate heritability in the preferences for fruits and vegetables (Breen et al. 2006), taste preferences depend largely on environmental and social factors and hence, can be modified (Patrick and Nicklas 2005, Wardle et al. 2003). The development of taste preferences begins as early as in utero, since the food eaten by the mother affects the molecules in the amniotic fluid and later in the breast milk (Ventura and Worobey 2013). When children begin to eat solid food, the key factor in getting them to like certain foods is repetition: children should be offered the same food repeatedly in a positive and supportive environment (Ventura and Worobey 2013). Studies conducted with preschool children, have noted that children started to like a previously disliked vegetable

after having tasted it five (Caton et al. 2013) or six times (Anzman-Frasca et al. 2012). Additional tasting occasions did not alter the reached effect nor was the adding of a dip, which would cover the previously disliked taste, necessary to boost the effect (Anzman-Frasca et al. 2012). In another study, mere exposure increased intake of the unknown vegetable and no increase was gained by combining the vegetable with a previously-liked taste or extra energy (Caton et al. 2013). A similar result of the impact of exposure was found in an intervention study conducted among 4–6 year olds (Cooke et al. 2011). The increase in liking vegetables was reached equally in a group with a mere exposure to vegetables, in a group receiving verbal praise for eating vegetables and in a group receiving a non-food reward for eating vegetables (Cooke et al. 2011). Even though mere exposure can be enough to change taste preferences among small children and no associative conditioning is needed to increase liking for vegetables, pairing a disliked vegetable with an already-preferred taste could encourage a child to taste the disliked vegetable in the first place (Anzman-Frasca et al. 2012).

There is also some evidence that in addition to exposure, modelling or rewarding can increase schoolchildren's liking for FV intake. An intervention, providing 6–9-year-old children fresh FV, promoted favourable imaginary peer modelling and gave stickers as reward for FV intake, increased children's liking for FV, when liking was measured directly after a 16 week intervention (Laureati et al. 2014). A follow-up measurement after 6 months, however, showed that this effect of increased liking was persistent only for fruits but not for vegetables (Laureati et al. 2014). The above-mentioned study lacked a pure control group since the intervention group was compared to a group which only received FV during the intervention, hence possible changes in liking for FV among children whose exposure to FV remained stable are unknown. The more persistent increase in liking for fruits was thought to be due to children's higher liking for fruits compared to vegetables, which has been demonstrated often (Laureati et al. 2014, Russell et al. 2014).

## 2.5 FRUIT AND VEGETABLE INTAKE, PREFERENCES AND GENDER

Gender is one of the main grounds for classifying people in our society. Distinct to the definition of 'sex', which refers to biological characteristics, 'gender' stresses the social construction and cultural aspects of the categorization of people as either female or male (WHO 2016). Since this dichotomization is held

afloat by addressing different roles and norms to different genders, the impact of gendered behaviour can be seen in gendered outcomes, also in the field of health (WHO 2016). Gender is a cultural construction, according to which social relations are organised, and it plays a central role in maintaining and reproducing inequalities (Correll 2007). In countries where gender inequalities are large, compared to societies with smaller gender inequalities, health outcomes are worse for both genders even when adjusting for wealth (Viner et al. 2012). Social practises related to gender form a system, which spreads from socioeconomic arrangements at the macro level, via conventions of how to behave at a social level, to identities at the individual level (Correll 2007). Gender differences in health and health behaviours are also systematic and persistent among school-aged children, although a recent WHO report noted that some equalization processes can be seen – but mainly as increased risk behaviour among girls (Inchley et al. 2016).

Girls have been reported to eat daily FV more often than boys do (Vereecken et al. 2015) as well as to eat more FV in magnitude (per unit energy) (Jones et al. 2010). However, gender differences have not been found in all studies, and results vary between measures and countries. In five out of ten European countries, 11-year-old girls have been reported to have both higher mean FV intake and higher prevalence of eating FV daily compared to boys of the same age (Lynch et al. 2014). In a Swedish study which measured FV intake frequency of at least twice a day, girls ate vegetables more often than boys but no gender differences were noted in fruit intake frequency (Elinder et al. 2014). There is also ambivalence regarding the onset time of gender differences in FV intake. In a Finnish study, FV intake among girls and boys did not differ as the children were 1- to 10-years old but the energy-adjusted FV intake became higher among girls first in the group of 9- to 11-year-olds (Talvia et al. 2006). Among Norwegian adolescents, gender difference in FV intake was higher among 16-year olds when compared to 11-year-olds (Fismen et al. 2014).

Although boys' lower FV intake has often been noted, the reasons behind gender differences have seldom been examined. Some studies have found no gender differences, for example, in parental support for FV intake (Pearson et al. 2009b). The parents of Icelandic boys have reported to provide more parental encouragement to eat FV compared to the parents of girls, whereas in the reports from the children, no gender differences were noted (Kristjansdottir et al. 2009). Since no objective measures of encouragement were employed, it can only be hypothesized whether boys really are encouraged more than girls but less likely to pay attention to such messages from the parents. Similarly, when

comparing the importance of the associates of FV intake for girls and for boys, some gender differences have been noted. For Icelandic girls, psychosocial factors, such as descriptive norms, were more important associates of FV intake, whereas for boys, environmental factors, such as availability and parental SES, had a stronger relation with FV intake (Kristjansdottir et al. 2006). Furthermore, among young adult women, positive attitudes of the significant other (girl-/boyfriend, spouse, partner) were found to be associated with FV intake adequate to guidelines, whereas among men such association was not found (Berge et al. 2012). A Dutch study concluded that already among 4- to 12-year old children, the associates of FV intake differ according to gender: for fruit intake, such factors as self-efficacy and intention to eat fruits were more important for girls than for boys (Reinaerts et al. 2007). Habit on the other hand, was a more important correlate of both fruit and vegetable intake for boys than for girls (Reinaerts et al. 2007). In contrary, however, a Danish study found no gender differences in children's self-efficacy to eat FV, outcome expectancies, nor descriptive or prescriptive norms related to FV intake (Pedersen et al. 2015).

A Norwegian study identified several determinants of FV intake which were higher among girls than boys: accessibility of FV at home, perceived FV intake of parents, peers and teachers, intention to eat FV, preferences for FV, self-efficacy to eat FV and knowledge of the recommendations (Bere et al. 2008). All of the abovementioned factors also acted as mediators between gender and children's FV intake. Still, most were not significant when they were adjusted for preferences for FV and accessibility of FV at home. Preferences had the strongest effect and explained 81 percent of the gender difference in children's FV intake in the single mediator analyses and 25 percent in the model where all mediators were examined together. (Bere et al. 2008.) This is somewhat incongruent with the results from the study conducted among older adults: nutrition knowledge alone explained higher FV intake among females whereas preferences, attitudes or dieting status did not contribute to the explanation of the gender differences in FV intake (Baker and Wardle 2003). Among people who were middle-aged, women's higher FV intake, compared to men, was partly explained by their positive attitudes for FV and higher self-efficacy to eat FV – or perceived behavioural control as it was conceptualised in the study (Emanuel et al. 2012). From the potential mediators, men scored higher in prescriptive norms, but since this construct was not associated with FV intake, norms failed to contribute to the explanation of gender differences in FV intake (Emanuel et al. 2012). By acknowledging the differences in the level of autonomy among children and adults, as well as the differing settings, more specific comparisons between these results might not be meaningful.

A vast number of studies have reported a higher liking for FV among girls compared to boys, in addition to a higher FV intake (Rasmussen et al. 2006). The time at which gender differences in liking for FV appear, remains unclear. In a study among 4-year olds (Wardle et al. 2001), girls were reported to like vegetables only marginally more than was the case with boys. Among a sample of 4–11 year old children, the gender difference in liking for FV was clear and stable: girls in all ages liked FV more than boys did (Cooke and Wardle 2005). In a study conducted among early adolescents, girls scored higher in liking for FV and during the follow-up of three years the gender difference in liking FV increased further (Bere et al. 2008). The increase in gender differences in liking for FV was due to decreased liking among boys and moderate increase in liking among girls (Bere et al. 2008). It seems that gender-specific decrease in liking for FV is not inevitable, since increase in liking for FV has been achieved similarly among both genders via school-based intervention using such methods as cooking and tasting programs (Cunningham-Sabo and Lohse 2013) or school gardening and nutritional education (Jaenke et al. 2012).

## 2.6 FRUIT AND VEGETABLE INTAKE AND SOCIOECONOMIC STATUS

Socioeconomic status is a factor which has impact on potential success of a person on many areas of life – including health and health behaviour (Marmot and Wilkinson 2005). Socioeconomic status specifies how a person is located socially and economically relative to other people in a certain society. Common indicators for socioeconomic status are person's educational level, personal or household income and occupation. In some studies, a person's wealth, employment status, or neighbourhood socioeconomic characteristics are considered as relevant indicators of a person's socioeconomic status. In studies with children, socioeconomic status of the parents is used to express the socioeconomic background that the child is thought to originate from, but sometimes area level indicators of school socioeconomic status are also used, as discussed later in this chapter. Depending on the socio-cultural and political features of the environment, or the country from which the study population originates, some measurements of socioeconomic status might be more suitable than the others. Among the adult population, different SES indicators have been found to have different kinds of predictive power on dietary behaviour as well as morbidity and mortality (Geyer et al. 2006, Turrell et al. 2003). Some criticism has also been expressed against the common model in health research in which



the same SES indicator is thought to be a similar representation across different racial/ethnic groups or genders (Braveman et al. 2005). Compared to the United States, from where the above-mentioned study originates, Finland has traditionally presented a more homogenous population structure and no comparative studies of the correspondence of SES in groups of different ethnic backgrounds, for example, have been conducted. There are, however, some indications that the diversification of population structure can affect also behaviour such as FV intake. In Sweden, low parental educational level (PEL) was similarly associated with children's low vegetable intake, both among children with parents born in the Nordic region and parents who had immigrated from further abroad (Säfsten et al. 2015). Nonetheless, children derived from a migrant background reported higher FV intake, even when the PEL was controlled for (Säfsten et al. 2015).

Lower socioeconomic background has often been associated with lower FV intake among children (Rasmussen et al. 2006), although the association has not been demonstrated in all studies (Attorp et al. 2014). Especially higher PEL has been found to be consistently associated with children's higher FV intake (Jones et al. 2010, Lioret et al. 2010, Rasmussen et al. 2006). In addition to higher PEL, parent's occupation was also associated with children's higher FV intake, but income showed no association in the FV intake among Norwegian 13- to 19-year-olds (Nilsen et al. 2010). Children's FV intake is not impacted by the circumstances of their own family alone. Higher school-level SES (more children with parents in higher ranked occupations) has been, in addition to family affluence and occupation, associated with children's higher fruit intake (Vereecken et al. 2005). There can also be differences in the impact of SES measures on vegetable intake and on fruit intake, or the impact can differ among genders. In a Swedish study, children with higher PEL ate vegetables more often compared to children with lower PEL, but no PEL differences were found in fruit intake frequency (Elinder et al. 2014). In Australia, most studied indicators of low SES were associated with lower FV intake, but the relevance of them differed for fruits and for vegetables as well as for girls and for boys (Zarnowiecki et al. 2014). For boys, higher maternal educational level was associated with higher FV intake whereas for girls the strongest associate for high FV intake was their mother not being in the labour force. Contradictory to the results among boys, girls' higher fruit intake was associated with their mothers having a lower educational level (Zarnowiecki et al. 2014). The reasons for the associations of different direction or magnitude are not clear. There is also a lack of studies which have examined the factors mediating the effects between SES and children's FV intake.

When discussing the impact of socioeconomic background on children's FV intake, it is obvious that one cannot forget the impact of parental SES on parents' own thinking and behaviour. In Finland, for example, women with lower education level valued more the low price of the food, when compared to the group of higher educated women, and this difference in values partly explained the lower FV intake among less educated women (Konttinen et al. 2013). In addition, lower nutritional knowledge among first-time mothers has been found to partly mediate the association between low SES and poorer diet (McLeod et al. 2011). Parents influence the possibility of FV intake of their children by direct and indirect actions. They choose the environment they are living in, shape the food-related family practices, act as role models as well as embody and pass further thoughts and values. Higher SES was not only associated with children's higher frequency to eat fruits, but also higher parental descriptive norms, encouragement, demand to eat fruits and higher home availability of fruits (Sandvik et al. 2010). As the authors of the abovementioned study concluded, the relations between fruit intake and constructs of attitude-social influence-self-efficacy-model were moderated by SES (Sandvik et al. 2010).

It is understandable that if parents with higher SES have higher FV intake (Elfhag et al. 2008, Rodenburg et al. 2012) they would be more likely to have FV at home as well. Many studies have identified home accessibility of FV to be higher among children with higher socioeconomic background (Bere et al. 2008, Hilsen et al. 2011, Sandvik et al. 2010). In a Norwegian study, which had not found PEL differences in children's FV intake, still reported higher accessibility of both fruits and vegetables among girls with higher PEL but among boys the associations were significant only for fruits (Bjelland et al. 2011). Two other Norwegian studies (Bere et al. 2008, Hilsen et al. 2011) also identified home accessibility to partly explain the SES differences in children's FV intake. Moreover, the first-mentioned study found children's preferences to be another significant mediator (Hilsen et al. 2011) whereas in the latter study this was not the case (Bere et al. 2008). Parental habit of eating FV can be passed further to their children via different mechanisms and it is hard to know where to draw the line between environmental and internalized psychosocial factors. In a study with eight year old children (Rodenburg et al. 2012), from the association between higher fruit intake and higher parental educational level, 45 percent was attributed to higher parental fruit intake. This can be seen as a mechanism of descriptive norms. A Canadian study, on the other hand, identified parental prescriptive norms (children's perception that their parents think that the children should eat vegetables daily) as a mediator between parental educational

level and daily vegetable intake at school (Ahmadi et al. 2015). In addition to FV home availability and parent's own FV intake, parental rules that their child should eat enough FV to meet the recommendations has been found to act as mediator between higher maternal educational level and children's FV intake in the Netherlands (van Ansem et al. 2013).

An Australian study conducted among 9–13 year olds reported that the proportion of differences in FV intake that different measures of SES explained was small – only a couple of percent at best (Zarnowiecki et al. 2014). While not having evidence from a larger number of studies, the low predictive value of SES can be attributed to regional differences but also to children's age. A Norwegian study noted that the effect of PEL on children's FV intake was greater among 15-year-old adolescents than it had been when the subjects were twelve (Bere et al. 2008), although, the widening of the gap between SES groups was not noted for income and FV intake. Similarly, a review from Pearson et al. (2009a) concluded that SES differences in FV were seldom found among 6- to 11-year olds whereas these differences were more common among 12- to 18-year olds. On the other hand, a lower FV intake among Norwegian children with low PEL was already apparent in 18-month-old children, and this disparity tracked to the age of 7-years (Bjelland et al. 2013). SES is still an important aspect to be considered since in Europe the SES differences in FV intake are a serious problem among adult population (Irala-Estevez et al. 2000). Between the years 1979 and 2002, socioeconomic gradient in adults' vegetable intake frequency in Finland has somewhat diminished but the SES differences were still present in the last study year (Roos et al. 2008). Among Finnish children, no recent trends in socioeconomic differences in FV intake have been documented. In countries like Norway, where the prevalence of daily FV intake has increased in general, the socioeconomic differences in children's FV intake have not diminished (Fismen et al. 2014).

It is unlikely that only one identifiable reason can explain SES differences in FV intake, since SES groups are not homogenous collections of people. Moreover, different measurements used to define SES, such as education, income or occupation, each capture a somewhat different aspect of SES. Assuming that SES is a background factor that slowly forms behaviour, thoughts and values, it is understandable that SES differences in FV intake are harder to detect among children than among adults. It has been noted that along with FV intake, PEL differences in positive descriptive norms related to parents, friends, siblings and home economics teachers, as well as intentions to eat FV increased more among the high PEL group between the ages of twelve and fifteen so that among older

adolescents PEL differences had emerged (Bere et al. 2008). In some countries, including Finland, free school lunch is thought to equalize somewhat the children's nutritional status differences between SES groups. In addition, the effects of unhealthy eating habits, such as inadequate FV intake, are to be seen later in life (WHO 2002), as was discussed in the introduction section. It could also be argued that numerous interventions and campaigns have been effective and new generations would not face the situation where their socioeconomic status impacts their FV intake. The last argument is probably too optimistic, since the unfortunate fact which must be considered is that most children, regardless of SES background, do not meet the FV recommendations (Attorp et al. 2014).

## 2.7 INTERVENTIONS AIMING TO INCREASE FRUIT AND VEGETABLE INTAKE

Since most children fail to reach the recommended level of FV intake, numerous interventions that aim to increase FV intake have been carried out internationally in natural settings – among school-aged children mostly in schools. A common way to categorize school-based interventions in the field of public health is dividing them into two different types of interventions: single-component and multicomponent. Single-component interventions aim to increase FV intake by providing free or subsidized fruits or vegetables to children. Whereas single-component interventions rely on mere exposure (i.e. increase availability), multicomponent interventions strive for change by targeting psychosocial factors such as children's knowledge, attitudes and motivation. In addition to the provision of FV, multicomponent programs, therefore, comprise education curriculum and often also parental involvement. Table 1 summarizes the results of school-based intervention studies which are discussed in more detail in this section. Interventions can also be thematised according to a COM-B model: in order to change a person's behaviour (B), changes in some or all prerequisites (and outcomes) of behaviour – capability (C), opportunity (O) and motivation (M) – might be needed (Michie et al. 2011). This means that addressing capability to eat FV would imply changes in knowledge or self-efficacy, opportunities to increase FV intake could demand changes in availability of FV as well as norms, and increased motivation would mean increased liking or attitudes.

**Table 1.** Relevant studies for the present thesis presenting the intervention effect of school-based interventions on children's FV intake.

Study	Type of the intervention	Dose / content	Country	Sample size	Follow-up length	Age (y) or grade ( <sup>th</sup> )	Psychosocial factors	Intervention effect positive (+) / negative (-) / no association (ns)
Barr et al. 2014	Single-component	2 F /week every 2 <sup>nd</sup> week	Canada	668	4 months	12 y	Self-efficacy, knowledge	ns all
Bere et al. 2015	Single-component	Daily free FV 1 <sup>st</sup> y	Norway	320	1, 4 & 7 y		-	+ FV intake 1 <sup>st</sup> ns FV 2 <sup>nd</sup> & 3 <sup>rd</sup>
Bjelland et al. 2015	Multicomponent	School curriculum, FV breaks	Norway	2165	2 y	11–13 y	-	+ F intake ns V intake
Christian et al. 2014	Multicomponent	Level of school gardening	Great-Britain	641	18 months	8 y	-	+ FV intake
Cunningham-Sabo et al. 2014	Multicomponent	Cooking lessons, FV tasting	USA	961	6 months	4 <sup>th</sup>	Preferences, attitudes, self-efficacy	+ Preferences, attitudes, self-efficacy
Fogarty et al. 2007	Single-component	Daily free F 1 <sup>st</sup> y	Great-Britain	5606	1 & 2 y	4–6 y	-	+ F intake 1 <sup>st</sup> - F intake 2 <sup>nd</sup>
Laureati et al. 2014	Multicomponent	FV tasting, rewards, videos	Italy	560	16 days & 6 months	6–9 y	Liking	+ FV liking 1 <sup>st</sup> & F liking 2 <sup>nd</sup> ns V liking 2 <sup>nd</sup>
Panunzio et al. 2007	Multicomponent	School curriculum	Italy	521	6 & 9 months	10 y	-	+ FV intake 1 <sup>st</sup> & 2 <sup>nd</sup> (teacher led) + FV intake 1 <sup>st</sup> (nutritionist led) ns FV intake 2 <sup>nd</sup> (nutritionist led)

Ransley et al. 2007	Multicomponent	Daily free FV, cooking, games	Great-Britain	3703	3 & 7 months	4–6 y	-	+ F 1 <sup>st</sup> & 2 <sup>nd</sup> ns V intake 2 <sup>nd</sup>
Reynolds et al. 2002	Multicomponent	School curriculum & catering, parental involvement	USA	1676	1 & 2 y	10 y	Attitudes, self-efficacy, knowledge	+ FV intake 1 <sup>st</sup> & 2 <sup>nd</sup> + Attitudes
Reynolds et al. 2004	Multicomponent	School curriculum & catering, parental involvement	USA	1584 & 522	1 y	9 & 10 y	Attitudes, self-efficacy, knowledge, availability, parental FV intake	+ FV intake + Knowledge
Tak et al. 2010	Single-component	2 free FV /week	The Netherlands	705	1 & 2 y	9–10 y	-	+ FV brought to school
Wind et al. 2008	Multicomponent	Lessons, FV program, parental involvement	The Netherlands, Norway, Spain	2106	21 months	10–13 y	-	+ FV intake

The effect of interventions depends on many aspects ranging from the content of the intervention program to the characteristics of its implementation and the target population. Recent reviews (Evans et al. 2012, Van Cauwenberghe et al. 2010) concluded that multicomponent interventions have been more effective in increasing children's FV intake compared to single-component interventions. A systematic review and meta-analyses (Delgado-Noguera et al. 2011), on the other hand, found only a trend of significance for multicomponent interventions, probably due to the heterogeneity of the included studies. Some researchers have stressed that the missing effect of a single-component intervention can simply be due to the inadequate frequency with which free FV have been provided (Barr and Scott 2014). There have also been, however, efficient interventions which have relied solely on the provision of free FV at schools, but the increase in children's FV intake (Bere et al. 2015) or fruit intake (Ransley et al. 2007) have been lost with time – sometimes the decrease being even stronger in the previous intervention group compared to the controls (Fogarty et al. 2007). Still, in addition to the increase in FV intake, when an intervention is conducted, eating FV intake can replace some other unhealthy eating habits among children. Some studies have noticed that free FV provision at schools had yielded in decrease of unhealthy snacking both in the case where intervention also had increased FV intake (Tak et al. 2010) and in the case where children's FV intake had decreased from the level that had been reached directly after intervention (Bere et al. 2015).

Increase in FV intake can indeed be partly dependent on the received dose or, in different kinds of interventions, the strength with which the intervention is carried out. In a multicomponent intervention conducted in three European countries (Wind et al. 2008), for example, higher implementation level led to higher increase in children's FV intake. Similarly, a school gardening intervention had no impact on children's FV intake when the implementation level was low, but an increase in the implementation level resulted in an 81 gram increase in the average daily FV intake (Christian et al. 2014). As in the above-mentioned gardening intervention, the question which mostly remains unanswered is what changes qualitatively when the quantity, i.e. the implementation level, of an intervention increases. As shown in a European-wide study (Wind et al. 2010), availability of fruits had not only direct effect on children's FV intake, but that association was partly mediated by liking for fruits and self-efficacy to eat fruits.

In addition to the benefits of including several components and being implemented at a higher level, interventions which are theory based have been

found to be somewhat more efficient in increasing children's FV intake than non-theory driven interventions (Diep et al. 2014). When additionally controlling for the quality of the study, theory-based interventions seemed to have an effect only on children's vegetable intake (Diep et al. 2014). Still, the positive effect of theory-based interventions on vegetable intake is notable, since vegetable intake appears to be harder to increase than fruit intake. As Evans et al. (2012) conclude, most school-based interventions have increased fruit intake somewhat but have had little or no effect on children's vegetable intake. Children's liking for both fruits and vegetables could also be increased in an intervention which provided FV and gave rewards for FV intake (Laureati et al. 2014). This effect of increased liking, however, was maintained for 6 months only for fruits (Laureati et al. 2014).

As shown above, the implementation level appears to be an important determinant of the efficacy of an intervention. Less conclusive results have been received from the few studies examining the role of the different implementers on the magnitude of the intervention impact. School gardening intervention was as effective whether it was led by a teacher or specialist outside school environment to yield in increase in FV knowledge or positive attitudes related to FV but neither of them increased children's actual FV intake (Hutchinson et al. 2015). A multi-component intervention implemented by a teacher increased FV intake more than when it was implemented by a trained nutritionist, although the latter increased FV intake somewhat as well (Panunzio et al. 2007). The authors attributed the greater impact of teacher-led intervention to the possibly higher authority of the teacher compared to the nutritionist, but due to lack of further research, it can only be hypothesized whether such factors as pedagogical skills, motivation or closeness to the children would be of importance.

The effects of interventions have seldom been reported separately for different subgroups. A review of interventions on different energy balance-related behaviour (EBRB) identified children's gender to be the most consistent moderator of intervention efficacy (Yildirim et al. 2011). The finding that girls benefitted more from the interventions was attributed to their lower baseline levels of EBRB (especially in physical activity), as well as to their socially desirable responding or more reliable self-reports (Yildirim et al. 2011). There is, however, evidence that both girls and boys benefitted similarly from interventions that yielded an increased liking for FV (Laureati et al. 2014), fruit intake (Bjelland et al. 2015) and FV intake (Tak et al. 2010). Taking into account the fact that boys often have lower FV intake than girls, interventions could be



hypothesized to be more efficient among boys since in their initial diet warrants more room for improvement. This has been the case in a Finnish nutrition counselling intervention for families, where FV intake increased only among boys, but not among girls (Talvia et al. 2006), and a school cooking intervention in the United States which increased liking for FV more among boys than among girls (Cunningham-Sabo and Lohse 2014). A Norwegian school-based intervention increased fruit intake similarly among all children regardless of their gender or PEL and, on the other hand, was similarly inefficient in increasing vegetable intake among children across all PEL groups (Bjelland et al. 2015). Interestingly, intervention effect spread to the home environment by increasing vegetable intake of the fathers, but only if they were higher educated and had relatively high vegetable intake already at baseline (Bjelland et al. 2015). Sub-group analyses, which were conducted afterwards for intervention studies in order to determine whether interventions were equally efficient in increasing healthy eating among children with low and high parental SES, demonstrated similar effects across different socioeconomic groups (Lien et al. 2014).

Most reviewed interventions could not identify any significant mediators which would explain the effect between the intervention and children's FV intake (van Stralen et al. 2011). The lack of the mediation was mainly observed because the interventions did not change the hypothesized mediators such as self-efficacy, different kinds of social influences, or availability (van Stralen et al. 2011). In only two studies, knowledge (Reynolds et al. 2004) and attitudes (Reynolds et al. 2002) acted as mediators between intervention and FV intake, but even these effects faded after the first year's follow-up. Considering the importance of the implementation level of the intervention on increasing children's FV intake, it can be hypothesized that the change required in the mediators would also be dependent on the implementation level, as well as on the use of adequate behaviour change techniques. Since there are often limited resources that can be used in an intervention, it would be beneficial to know, whether there are determinants of FV intake which could be targeted efficiently also in interventions of smaller magnitude.

## 2.8 SUMMARY OF THE PREVIOUS RESEARCH

Most children in Finland, as well as in other post-industrial countries, do not eat an adequate amount of FV in order to meet the recommendations for a healthy

diet. Already low FV intake in childhood decreases further when children approach adolescence. Since eating patterns that are established in childhood tend to track into adulthood, several campaigns and school-based interventions have been carried out aiming to increase children's FV intake. Most of the interventions, however, have not been able to increase FV intake and its predictors considerably, or the positive intervention effect has faded away during the follow-up. This indicates that more detailed knowledge about the changeable determinants of FV intake is required. Children's infrequent FV intake is known to depend on many different environmental and psychosocial factors, from which availability of FV and liking for FV are factors that have received the most consistent support in previous studies. Parents are important in setting the frames that enable children's FV intake but they also act as role models for their children's FV intake. When growing older, children spend more time with their peers and friends but the knowledge of friends' impact on children's FV intake is mainly limited to experimental studies with small sample sizes.

Socioeconomic and gender differences in FV intake can already be seen among quite young children: boys and children with lower socioeconomic background tend to have the lowest FV intake. Still, little is known about the mechanisms by which gender and socioeconomic background enact their impact on liking for FV and consequently, on FV intake. It has been noted recently that the factors associated with fruit intake differ somewhat from those for vegetable intake. Variance in food culture across countries is also believed to cause diversity in the importance of environmental and psychosocial factors on children's FV intake. The limitation of most previous studies examining the predictors of children's FV intake is that fruits and vegetables are examined together. Moreover, there is still a shortage in research conducted in longitudinal settings. In order to increase the infrequent FV intake among children, it is beneficial to gain more detailed information regarding the factors that could be stressed in the future interventions.

### 3 THE AIMS OF THE STUDY

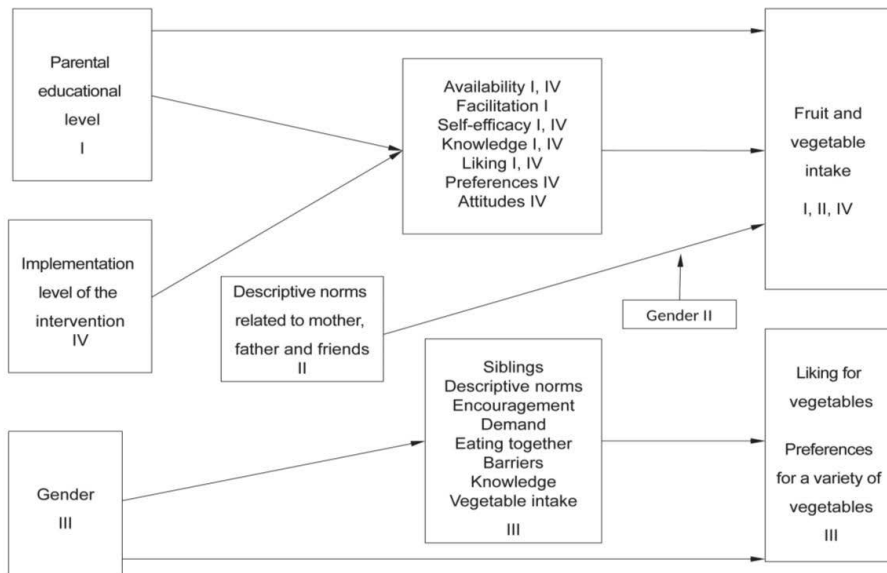
The general aim of the study was to attain more detailed knowledge of the factors determining fruit intake and vegetable intake among 11- to 12-year-old children. Whether these factors are of similar importance for girls and boys, or whether they can explain the gender or socioeconomic differences in children's FV intake, was of particular interest. Since liking for vegetables is known to be one of the best predictors for children's vegetable intake, analyses were conducted to identify which factors predict the formation of liking and gender differences in liking. An intervention effect on possible environmental and psychosocial predictors and on FV intake was also studied regarding the implementation level of the intervention. Gender, children's socioeconomic background, and different psychosocial and environmental factors were included in the studies as predictors, moderators, or mediators depending on the specific research questions.

Specific research questions in the four studies of the thesis were:

1. Are there socioeconomic differences in children's FV intake and which environmental and psychosocial factors could explain these hypothesized differences in ten European countries? (Study I)
2. Can girls' higher FV intake be explained by gender-specific perception of parental FV intake? Is the perceived FV intake of friends as important as perceived FV intake of parents for children's FV intake? (Study II)
3. Which factors explain girls' higher liking for vegetables and preferences for a variety of vegetables? (Study III)
4. Which environmental and psychosocial factors mediate the effect of a school-based intervention on children's FV intake? Does the level of implementation have an impact on the intervention outcomes? (Study IV)

Figure 2 shows the hypothesized associations between children's FV intake, gender, socioeconomic background, intervention and different psychosocial and environmental factors which act as predictors of FV intake. Higher parental

educational level and being a girl are assumed to be associated with higher FV intake or liking for vegetables and preferences for a variety of vegetables. The aforementioned associations are assumed to be partly explained by mediators listed in the figure.

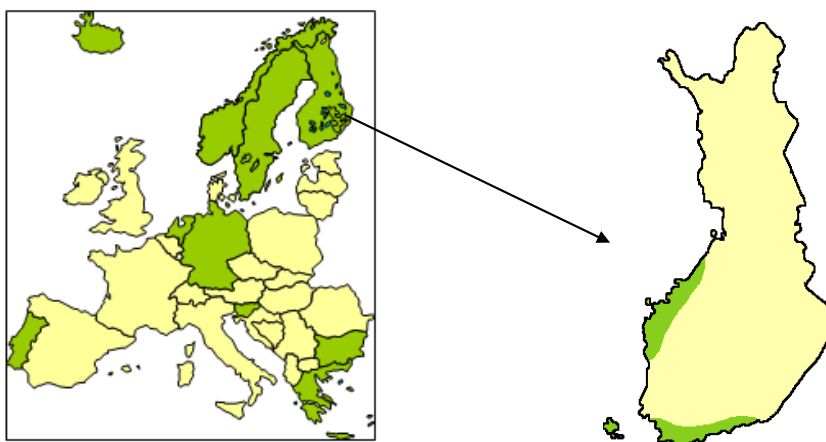


**FIGURE 2.** A conceptual model of the study. The roman numerals indicate which study the variables were included in.

## 4 METHODS

### 4.1 STUDY SETTING AND SAMPLE

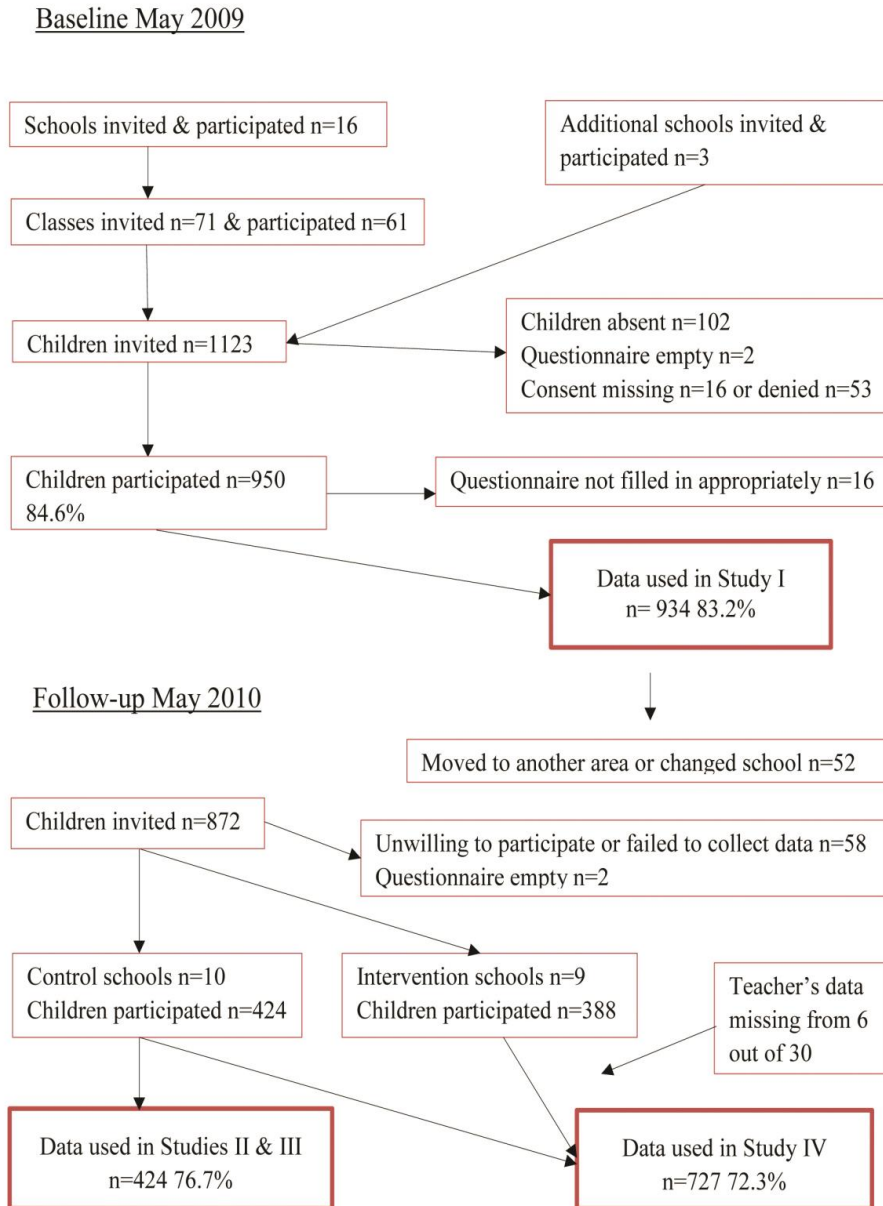
This study uses the data which was collected in the PRO GREENS project. PRO GREENS is a project which was financed by the European commission and aimed to increase FV intake among school children on the European level. The survey was conducted in May 2009 and May 2010 in ten European countries: Bulgaria, Finland, Germany, Greece, Iceland, the Netherlands, Norway, Portugal, Slovenia and Sweden (Figure 3). Each country should recruit at least 1000 children at the age of eleven years and the countries could decide for themselves the suitable way to do it. The sample was representative in the Netherlands and in Slovenia, whereas in the other countries the samples were recruited regionally for practical and financial reasons. In Finland, only Swedish speaking schools in the western and southern coastal area were recruited. The schools located in the capital area were excluded from the sample since in that area there had been an intervention that aimed to increase children's FV intake just some of years before.



**FIGURE 3.** Map of the ten European countries which participated in the PRO GREENS project and in more detail the study areas in Finland.

The schools received an invitation letter to participate in the study and a telephone call reminder followed if the schools had not responded. All nineteen schools and classes (5<sup>th</sup> and 6<sup>th</sup> grade) that decided to participate were included in the study. Depending on country, one to eleven classes per school took part. In Finland, all invited schools participated. If schools provided the addresses of the parents, they received by mail an invitation letter, consent form and a questionnaire. In other cases the letters and questionnaires were sent home with the children. In Norway, parents completed an online or a paper-and-pencil questionnaire. Children whose parents allowed their participation completed a paper-and-pencil questionnaire in nine countries and an online questionnaire in Norway. These questionnaires measured children's FV intake, factors related to it and in the follow-up also children's experiences from the intervention. Teachers conducted the study in the class-rooms during school hours. Children could ask questions for clarification where required. Baseline measurements took place in May 2009 when children reported their FV intake and factors that were thought to be associated with FV intake. Only in Finland, due to a human error which led to the exclusion of one page of the questionnaire, children reported their baseline FV intake first in August-September 2009. The follow-up took place in May 2010 when children filled in the same questionnaires as at baseline and additionally some questions concerning the intervention. Despite the above-mentioned dissimilarities, the data was collected according to the same protocol and the questionnaires were translated and back-translated by two separate persons in each country.

Study I uses the cross-sectional baseline data of all ten countries (n=8159). Studies II and III use the longitudinal data from control schools in Finland and in Study IV the longitudinal data from both control and intervention schools in Finland is applied. More specific information of the division of the participants and the participation rate in Finland is presented in Figure 4.



**Figure 4.** The division of the data of the PRO GREENS project in Finland with number of the participants (n) and participation percent of the eligible sample (%).

## **Intervention**

The PRO GREENS intervention was developed using the Intervention Mapping method (Bartholomew et al. 2011). According to Intervention Mapping, an intervention should be characterized by three aspects: use of established theories and empirical evidence, taking into account the socio-ecological approach and emphasizing the participation of relevant stakeholders. Intervention Mapping is an approach which aims to offer tools to conduct an intervention throughout the whole process: from the needs assessment, through intervention development and implementation to the process evaluation. (Bartholomew et al. 2011) Since the PRO GREENS intervention was based on the previous Pro Children project, the theoretical framework behind the original project was applicable also to the PRO GREENS intervention. The conceptualization and design of the Pro Children intervention have been reported in detail elsewhere (Klepp et al. 2005, Perez-Rodrigo et al. 2005). For developing the questionnaires and for shaping the original project, the following theories were applied: Social Cognitive Theory (Bandura. 1997), Attitude–Social influences–Self-efficacy-model (Kok et al. 1996), the Theory of Triadic Influence (Flay and Petraitis 1994) and Social-Ecological Model of Health Behaviour (French et al. 2001). The central, common content in the above-mentioned theories is the understanding of behaviour as interplay of one's own knowledge, preferences and skills on the one hand and influence of the social interaction and environment on the other hand. Even though the PRO GREENS intervention originated from a previous intervention, which had a theoretical background, for PRO GREENS practical criteria was stressed: it had to be a low cost intervention which could be implemented by the teacher.

The different components of the PRO GREENS intervention are presented in Table 2. The intervention consisted of four core elements: classroom sessions about taste, classroom sessions about the recommendations for FV intake with the assessment of one's own FV intake, encouragement to bring daily FV snacks to school and a weekly FV bring-a-dish event in the classroom. The intervention was applied according to the intervention protocol and included the same core elements in each country. In order to secure the cultural relevance and due to the differences in, for example, the school food systems and other local circumstances, the intervention was not identical in all countries. Thus the following description applies to Finland only. The intervention took place between September 2009 and the end of April 2010. Prior to the intervention, a research coordinator visited all intervention schools. The visits aimed at meeting the teachers who would accomplish the intervention later, motivating them,



informing them of the core elements of the intervention and introducing them the content of the teacher’s manual for the intervention. The manual which was given to the teachers during the meeting included instructions on how to carry out each component of the intervention. The teachers were responsible for implementing all components of the intervention on the class level. Intervention classes received some posters but no additional material or FV was given to them. In Finland, children receive a free school lunch on each school day, which always includes salad or raw vegetables but usually no fruits are served. There were no school-level actions except the letter which was sent to the headmasters. Parents were asked to take part in the interventions by helping children with two home assignments and to supply children with FV which they could take to school to be eaten in the snack breaks.

**Table 2.** The components of the PRO GREENS intervention.

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Classroom sessions:

1. The first taste test: senses and basic tastes
2. The second taste test: variation and different FV
3. Preferences and appreciation of FV
4. 5-a-day, how much is it?
5. Recommendations and own FV intake
6. Goal setting for own FV intake
7. How to increase FV intake? Tips for different meals.

Other elements:

- Daily fruit/vegetable snack
  - Weekly fruit/vegetable bring-a-dish
  - Two home assignments
  - Two letters to the parents
  - A letter to the principal
- 

## 4.2 ETHICAL CONSIDERATIONS

The PRO GREENS study protocol was approved by the research ethics committees in each participating country: 1) The Commission of Medical Ethics at the National Centre of Public Health Protection, Sofia, Bulgaria; 2) The Ethics Committee at the Department of Public Health, Faculty of Medicine, University of Helsinki, Finland; 3) The Ethics Committee of the Justus-Liebig University in

Giessen, Germany; 4) Ministry of Education, Lifelong Learning and Religious Affairs, Greece; 5) The National Bioethics Committee, Reykjavik, Iceland; 6) Medisch Etische Toetsingscommissie, VU medisch centrum, Amsterdam, Netherlands; 7) Norwegian Social Science Data Services (NSD), Bergen, Norway; 8) Ministry of Education, headmaster of School Julio Saul Dias and School Frei João de Vila do Conde, Portugal; 9) The National Medical Ethics Committee of the Republic of Slovenia, Ljubljana, Slovenia; and 10) Regional ethical review board, Stockholm, Sweden.

Both children and parents were informed that the participation is voluntary and they can withdraw from the study at any time. Parents provided their informed written consent for themselves and for their children.

#### 4.3 MEASURES

Parents reported their educational level and teachers documented how thoroughly they had implemented the intervention. All other factors were noted by the children themselves. The questions were adapted, with minor changes in wording, from the Pro Children questionnaires (De Bourdeaudhuij et al. 2005, Haraldsdóttir et al. 2005). The questionnaire that children completed was divided into two parts: first, different questions were asked concerning the associates of children's fruit intake and thereafter the same questions (with minor differences, if needed) were presented concerning vegetable intake. In the next sections questions are presented only once if the questions were similar for the assessment of fruit intake and vegetable intake. Only if the questions were different concerning fruit intake and vegetable intake, they are presented here separately. It is stated in the brackets after the definitions in which studies the questions were included in. Cronbach's alphas for the variables included in Study I are presented in Appendix 1 for all participating countries.

##### **Fruit and vegetable intake**

Children's FV intake was measured with the questions that were adapted from a Food Frequency Questionnaire (FFQ) which had been validated before in five European countries (Haraldsdóttir et al. 2005). Children were asked to separately indicate their intake frequency of fruits, salad, other raw vegetables and cooked vegetables on a following scale: 1) Never; 2) Less than once a week; 3) Once a week; 4) 2-4 days a week; 5) 5-6 days a week; 6) Every day, once a

day; 7) Every day, twice a day; and 8) Every day, more than twice a day. There were neither questions about the portion size nor about the intake frequency of berries. The intake frequency of salad, raw vegetables and cooked vegetables were added together to form a variable which indicates children's vegetable intake. The answer alternatives were re-weighted so that the answers would indicate the times a child eats fruit or vegetables per day. (Studies I, II, III and IV)

### **Psychosocial factors**

*Liking* was defined with statements "I like to eat FV every day" and "FV taste good". The child was asked to indicate her/his agreement with the statement by choosing one of the answer alternatives: 2) I fully agree; 1) I agree somewhat; 0) I neither agree nor disagree; -1) I disagree somewhat; and -2) I fully disagree. (Studies I, III and IV)

*Preferences* refer to children's preferences for a variety of different kinds of FV. Children rated 14 different fruits and berries and 16 different vegetables according to their preferences with a scale ranging from 2) I like a lot to -2) I dislike a lot, zero being I haven't tried. (Studies III and IV)

*Eating together* was defined as "I often eat vegetables together with my family". (Study III)

*Perceived barriers* to eat vegetables was a sum variable of the following statements "I do not eat vegetables because it takes too long to eat them", "I do not eat vegetables because I am still hungry after having eaten them" and "I do not eat vegetables because I want to eat something else (e.g. sweets)". (Study III)

*Descriptive norms / perceived fruit or vegetable intake* of significant others was measured with three statements "My mother/father/best friends eat(s) fruits/vegetables every day". (Studies II and III)

*Parental encouragement* was asked about with two statements "My mother/father encourages me to eat vegetables every day". (Study III)

*Self-efficacy* to eat FV was conceptualized with the statements "It is difficult for me to eat FV every day" and "If I decide to eat FV every day, I can do it". (Studies

I and IV)

*Attitudes* concerning the benefits of eating FV were assessed with two statements: “To eat FV every day makes me feel good” and “To eat FV every day gives me more energy”. (Study IV)

The answer alternatives for the above-mentioned questions measuring descriptive norms, encouragement, attitudes, barriers, eating together and self-efficacy were: 2) I fully agree; 1) I agree somewhat; 0) I neither agree nor disagree; -1) I disagree somewhat; and -2) I fully disagree. For the questions measuring descriptive norms in relation to FV intake of mother/father and parental encouragements, children could also choose an alternative: 6) I do not have /meet (a) mother/father. Children who chose this alternative (n=15) were excluded from the analyses.

*Parental demand* was assessed with the question “Do your parents demand that you eat fruit/vegetables every day?” The answer alternatives for this question were: 2) Yes, every day; 1) Yes, on most days; 0) Sometimes; -1) Seldom; and -2) Never. (Study III)

*Facilitation* indicates parental behaviour which is considered to make eating of FV easier for the child. Answer alternatives for the question “Does your mother or father usually cut up FV for you in between meals?” were: 2) Yes, always; 1) Yes, on most days; 0) Sometimes; -1) Seldom; and -2) Never. (Study I)

*Knowledge* of the recommended amount of FV needed for a healthy diet was assessed with the statement “How many FV do you think you should eat to have a healthy diet?” The answer alternatives for these questions were: 1) No fruit/vegetables; 2) 1-3 portions per week; 3) 4-6 portions per week; 4) 1 portion per day; 5) 2 portions per day; 6) 3 portions per day; 7) 4 portions per day; and 8) 5 or more portions per day. The alternatives were recoded to indicate the child’s opinion of the portions of FV that one should eat per day. The answers concerning both fruit intake and vegetable intake were added together and the final answer alternatives could then range from zero to five. (Studies I, III and IV)

## **Environment**

*Availability* of FV at home was measured with questions “Are there usually

different kinds of FV available in your home?” (asked separately both for fruit and vegetables) and “Is there usually a fruit bowl (or similar) in the kitchen or living room?” (asked only for fruit intake) or “In your home, are there usually vegetables served with dinner (or lunch)?” (asked only for vegetable intake). This variable was included as a mediator in Studies I and III. In Study IV, ‘availability’ implied the taking of FV as a snack to school. This was measured with the questions “Do you usually bring FV with you to school?” The answer alternatives for both kinds of availability were: 2) Yes, always; 1) Yes, in most days; 0) Sometimes; -1) Seldom; and -2) Never.

*Having brother(s) or sister(s)* was assessed by asking the child to write down the amount of her/his brothers and sisters. (Study III)

*Parental educational level* was received from the parental questionnaire. The respondent parent indicated her/his highest attained education from the following alternatives: 1) Not completed elementary school; 2) Elementary school; 3) High school; 4) Senior high school; 5) College or university; or 6) Other education, indicate which. The sixth alternatives were inspected in detail and re-coded to be included in the categories one to five if that was possible. In other cases persons who had chosen the sixth alternative were omitted from the analyses. For the sub-study I, this variable was dichotomized to a lower to middle level educational level (including alternatives from 1 to 4 or in Bulgaria and Slovenia alternatives from 1 to 3) and to a higher level educational level (including alternative 5 or in Bulgaria and Slovenia alternatives 4 and 5). This was done due to the country differences in the length and requirements of the educational levels. In other Studies (II, III and IV) parental educational level was a continuous variable which was treated as a covariate in the analyses. (Studies I, II, III and IV)

## **Gender and age**

Children reported whether they were girls or boys and both their birth month and year.

## **Implementation of the intervention**

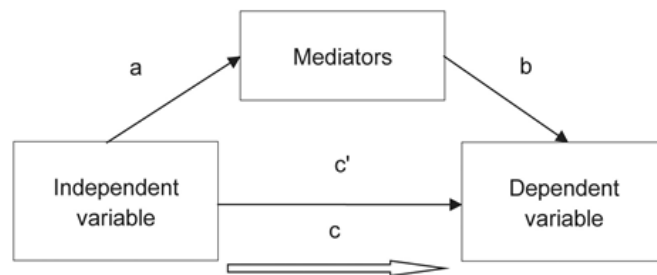
Teachers had been asked to keep a logbook about the intervention activities during the study year. In the follow-up, teachers rated the degree of the

implementation of the intervention. Teachers were asked an open-ended question about the lessons that they implemented “How many lessons have you used to implement PRO GREENS during this school year?” They rated the question “Did you have snack breaks for fruits or vegetables in the class as part of the PRO GREENS project?” on a five-point scale ranging from “yes, on all days” to “no”. Both above-mentioned questions were recoded so that they could receive values ranging from zero to three. The questions, which could be answered with yes or no, assessed whether the teacher had accomplished taste tests and bring-a-dish events, or taken part in the teachers’ info meeting prior to the intervention. Every yes answer gave one point and the no answers were coded as zeros. Thereafter the answers of the above-mentioned questions were added together resulting in the range of zero to nine points in total. The group which had received points ranging from five to nine was considered to have a high level of the implementation of the intervention. The intervention was considered to carry a lower level of implementation when the points ranged between zero and four. The control group consisted of the children who were in the control schools and received no intervention. (Study IV)

#### 4.4 STATISTICAL METHODS

The bivariate associations between all variables were examined with Pearson’s correlation coefficients. The moderation analyses were accomplished to determine if the associations between predictors and the outcome variables were similar among girls and boys in the linear regression analyses (Studies II–III). In Study II, these examined associations were between the baseline measurements of descriptive norms and the follow-up measurements of children’s FV intake. In Study III, moderation analyses were performed for the association between the predictors and children’s liking for vegetables and preferences for a variety of vegetables. In moderation analyses, the predictor is multiplied with the moderator (in this case gender) and this interaction term is included as a predictor together with the main effects and children’s age in the analyses. Since the likelihood to detect a statistically significant difference in the moderation effect is lower than in the main effects (Clayton et al. 1993), the significance level in the moderation analyses was set to  $p < 0.10$ . Still, the moderation effect was found only in one association in the Study II and thus the results for all other analyses both in Studies II and III are presented together for girls and boys. Except the moderation analyses for all other analyses the level of statistical significant was set at level  $p < 0.05$ . The mediation analyses were

accomplished in Studies I, III and IV. Mediation, which is also presented in Figure 5, is thought to occur if a third factor (a mediator) explains the association between two other factors. In the mediation analyses, the total effect between the independent and dependent factors (path c) is examined without controlling for mediators and the direct effect is the same association between the independent and dependent factors after controlling for the mediators (path c'). The associations between the independent factor and the mediators (path a) and between the mediators and the dependent factors (path b) are also assessed. These two associations form the indirect path ( $a \times b$ ) between the independent and dependent factors referred as mediation. The sampling was nested as it was conducted in school classes. To rule out the possible effect of nested sampling (children in the same school classes) all regression analyses were conducted with a correction to the higher group level. All statistical analyses were performed with SPSS (versions 20.0 – 22.0) and, in case the nested sampling had to be taken into account in the regression analyses, with *Mplus* statistical software (versions 7.1 – 7.3) (Muthén and Muthén 1998-2012).



**FIGURE 5.** A model illustrating associations between an independent variable, possible mediating variables and a dependent variable. Path a represents the association between an independent variable and mediators, and path b represents the association between mediators and a dependent variable. Path c' is the direct effect and path c is the total effect between an independent and a dependent variable.

In Study I, associations between PEL (dichotomized to lower/middle and higher level education) and children's daily FV intake were examined with logistic regression analyses. In the mediation model availability of FV at home, facilitation, liking, self-efficacy and knowledge were included in the model as potential mediators explaining the association between PEL and FV intake. All

analyses were conducted separately for ten participating countries and adjusted for children's gender and age.

In Study II, linear regression analyses were used to study how perceived FV intake of mother, father and friends predicted children's FV intake frequency. The similarity of the associations among girls and boys were tested with moderation analyses. Since no interaction effect was found, all analyses were adjusted for children's gender, age and parental educational level.

In Study III, gender differences in children's liking for vegetables and preferences for a variety of vegetables were predicted and we tested whether those associations could be explained by the following mediators: descriptive norms, parental encouragements and demands, eating together, availability of vegetables at home, perceived barriers, knowledge and previous vegetable intake. All analyses were adjusted for children's age.

In Study IV, the effect of a school-based intervention was examined on children's FV intake frequency. The implementation of the intervention was divided in three groups (control, slightly implemented intervention and strongly implemented intervention) and the mediators that the intervention tried to impact were taking FV with to school, self-efficacy, attitudes, liking for FV, preferences for a variety of FV and knowledge of the recommendations. To examine the change that occurred during the intervention year, these aforementioned mediator variables were residuals of the difference between baseline and follow-up measures. All analyses were adjusted for children's gender<sup>1</sup>.

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<sup>1</sup> Contrary to that what is claimed in the Study IV article, the mediation analyses were not adjusted for children's gender and age, but only for gender.



## 5 RESULTS

### 5.1 SAMPLE CHARACTERISTICS

The sample characteristics for the whole sample are presented by country in Appendix II. The response rate was 72 percent for the whole sample but varied between 92 percent in Greece and 52 percent in Norway. Each country demonstrated an approximately equal distribution of girls and boys. There was a great variance in PEL across the countries: 60 percent from the parents in Bulgaria had university-level education whereas in Germany the percentage was 18. Of all children, 47 percent reported eating fruits daily and 59 percent reported daily vegetable intake. Daily fruit intake frequency was highest in Iceland (56%) and lowest in Finland (33%). Daily vegetable intake frequency, on the other hand, was highest in Finland (71%) and lowest in Iceland (52%).

In Studies II and III, only half of the sample was included in the analyses (the participants in the intervention schools were excluded from the analyses). Therefore, the descriptive characteristics of the whole Finnish study sample (in control schools) are presented in Table 3. For the sample in the intervention schools, the relevant descriptive characteristics for the variables included in Study IV can be found in Table 8. Gender distribution was equal and half of the children had at least one parent with a university level education. At baseline, the mean age of the children was 11.4 years. Girls had higher intake frequency of fruits at baseline but the gender difference had become non-significant in the follow-up. Vegetable intake frequency was higher among girls than boys both at baseline and in the follow-up. At baseline, no gender differences in liking for vegetables were found but since the decrease in liking was greater among boys in the follow-up, girls had higher scores in liking for vegetables. Similarly, at baseline, girls and boys reported equally high preferences for a variety of vegetables but in the follow-up, girls' preference score was higher.

**Table 3.** Sample characteristics, mean and standard deviation (SD), separately by gender and for the whole Finnish sample derived from the control schools.

	Total	Girls	Boys	p-value <sup>†</sup>
	Mean (SD)			
N (%)	424	205 (48)	219 (52)	
Age B, years	11.4 (0.6)	11.3 (0.6)	11.4 (0.6)	0.332
Having brothers B	1.26 (1.27)	1.26 (1.40)	1.07 (1.13)	0.114
Having sisters B	1.14 (1.11)	1.14 (1.13)	1.13 (1.09)	0.937
Fruit intake B (times/day) ***	0.87 (0.75)	<b>0.97 (0.81)</b>	<b>0.78 (0.67)</b>	<b>0.009</b>
Fruit intake F-U (times/day) ***	0.85 (0.72)	0.92 (0.74)	0.79 (0.70)	0.062
Fruit intake, change	-0.02 (0.77)	-0.06 (0.83)	0.01 (0.70)	0.374
Vegetable intake B (times/day) ***	1.66 (1.18)	<b>1.91 (1.28)</b>	<b>1.42 (1.03)</b>	<b>&lt;0.001</b>
Vegetable intake F-U (times/day) ***	1.57 (1.12)	<b>1.79 (1.10)</b>	<b>1.37 (1.11)</b>	<b>&lt;0.001</b>
Vegetable intake, change	-0.09 (1.10)	-0.13 (1.17)	-0.06 (1.03)	0.523
Liking for vegetables <sup>*</sup> B	0.82 (1.00)	0.91 (0.94)	0.73 (1.05)	0.065
Liking for vegetables <sup>*</sup> F-U	0.58 (1.10)	<b>0.78 (0.99)</b>	<b>0.39 (1.17)</b>	<b>&lt;0.001</b>
Liking for vegetables, change **	-0.23 (0.95)	<b>-0.13 (0.93)</b>	<b>-0.34 (0.95)</b>	<b>0.022</b>
Preferences (vegetables) <sup>*</sup> B	0.42 (0.78)	0.46 (0.75)	0.38 (0.80)	0.284
Preferences (vegetables) <sup>*</sup> F-U	0.48 (0.78)	<b>0.56 (0.77)</b>	<b>0.41 (0.79)</b>	<b>0.047</b>
Preferences (vegetables), change **	0.05 (0.58)	0.10 (0.55)	0.01 (0.62)	0.126
Vegetable intake of mother <sup>*</sup> B	1.14 (0.94)	1.16 (0.95)	1.13 (0.92)	0.752
Vegetable intake of father <sup>*</sup> B	0.74 (1.12)	0.70 (1.09)	0.78 (1.15)	0.426
Vegetable intake of friends <sup>*</sup> B	0.47 (0.90)	0.52 (0.90)	0.43 (0.89)	0.305
Parental encouragement <sup>*</sup> B	0.17 (1.15)	0.24 (1.12)	0.11 (1.18)	0.262
Parental demand to eat vegetables <sup>*</sup> B	0.28 (1.12)	0.38 (1.09)	0.19 (1.13)	0.096
Eating vegetables together <sup>*</sup> B	0.46 (1.18)	0.51 (1.13)	0.41 (1.23)	0.410
Availability of vegetables at home <sup>*</sup> B	1.14 (0.78)	1.10 (0.79)	1.18 (0.77)	0.343
Perceived barriers to eat vegetables <sup>*</sup> B	-1.29 (0.90)	<b>-1.47 (0.72)</b>	<b>-1.12 (1.01)</b>	<b>&lt;0.001</b>
Knowledge of recommendations <sup>***</sup> B	3.55 (1.39)	3.57 (1.35)	3.54 (1.43)	0.812

<sup>\*</sup> Range between -2–2; <sup>\*\*</sup> Range between -4–4; <sup>\*\*\*</sup> Range between 0–5

<sup>†</sup> The difference in the means between girls and boys.

B = baseline, F-U = follow-up

# 5.2 THE MEDIATION OF PARENTAL EDUCATIONAL LEVEL ON CHILDREN'S FRUIT AND VEGETABLE INTAKE

The PEL differences in fruit intake in the ten European countries are presented in Figure 6. Children whose parents had a university-level education eat fruits more often than those children whose parents had lower- or middle-level education in the following countries: Bulgaria, Greece, Iceland, Norway and Portugal.

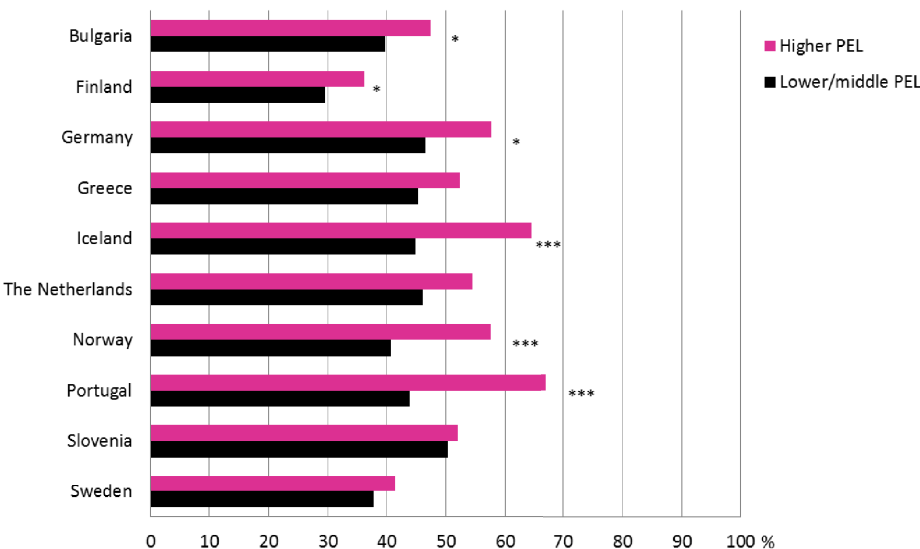


FIGURE 6. Children's daily fruit intake in the different European countries according to the parental educational level (PEL). The difference between PEL groups in daily fruit intake is indicated with \* $p < 0.05$ , \*\*\* $p < 0.001$ .

The PEL differences in children's daily vegetable intake in the ten European countries are presented in Figure 7. Children whose parents had a university-level education ate vegetables more often than those children whose parents had lower or middle level education in the following countries: Finland, Germany, Greece, Iceland, the Netherlands, Norway, Portugal and Slovenia.

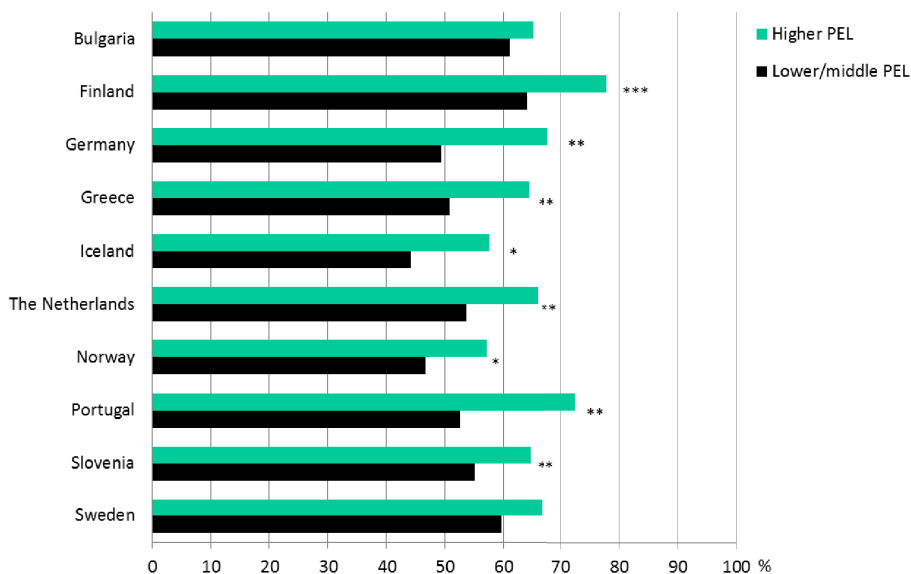
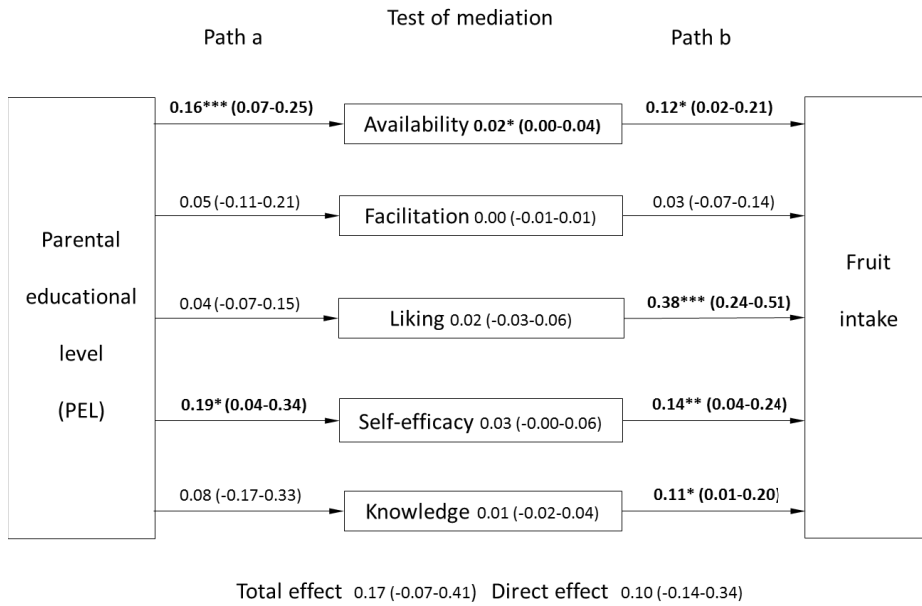


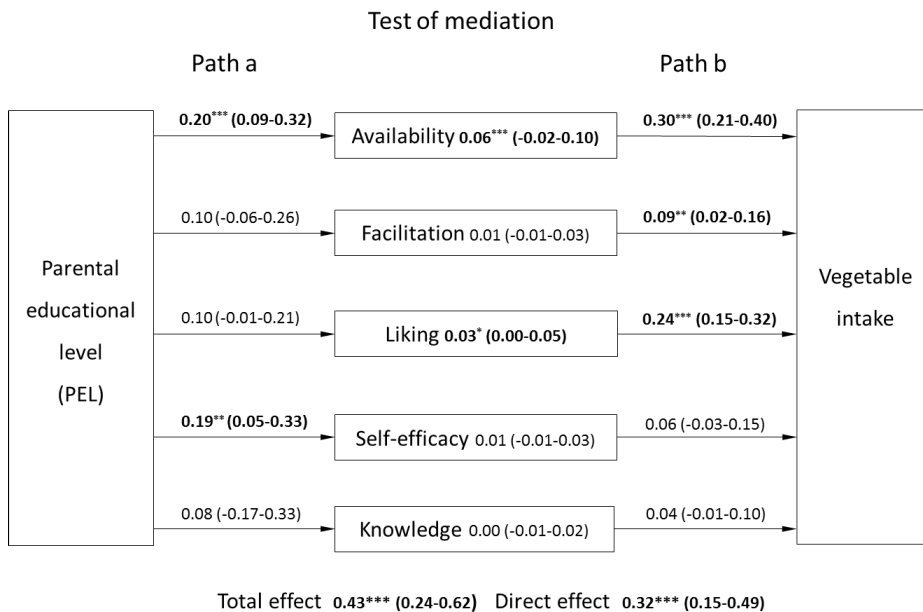
FIGURE 7. Children's daily vegetable intake in the different European countries according to the parental educational level (PEL). The difference between PEL groups in daily vegetable intake is indicated with \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$ .

In the Finnish study sample, there was no direct effect (path c') or total effect (path c) between PEL children's daily fruit (Figure 8). Higher PEL was associated with a higher level of availability of fruits at home and children's higher self-efficacy to eat fruits (path a). Daily fruit intake was associated with having fruits available at home, children's liking for fruits, self-efficacy to eat fruits and knowledge of the amount of FV needed to have a healthy diet (path b). A significant mediator for the association between PEL and children's daily fruit intake was availability of fruits at home (path a x b).



**FIGURE 8.** Mediation model presenting the unstandardized regression coefficients for the associations between parental educational level (PEL) and children's daily fruit intake in Finland. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

In the Finnish study sample, higher PEL was positively associated with children's daily vegetable intake (Figure 9). Higher PEL was also associated with higher level of availability of vegetables at home and children's higher self-efficacy to eat vegetables. Daily vegetable intake was associated with higher levels of availability of vegetables at home, parental facilitation and children's liking for vegetables. The association between PEL and children's daily vegetable intake was partly explained by availability of vegetables at home and children's higher liking for vegetables. The association between PEL and children's daily vegetable intake stayed significant also after controlling for the mediators.



**FIGURE 9.** Mediation model presenting the unstandardized regression coefficients for the associations between parental educational level (PEL) and children's daily vegetable intake in Finland. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

Analyses conducted separately for each participating country showed that there were country differences in the importance of the mediators between PEL and children's daily fruit intake (Table 4). Availability of fruits at home was a significant mediator in Finland, parental facilitation and children's liking for fruits in Norway, self-efficacy to eat fruits in Portugal and knowledge of the healthy diet both in Greece and Portugal.

Table 4. The mediated effects<sup>†</sup> between parental educational level and children's daily fruit intake in different countries arranged by statistically-significant mediators.

		B	95% CI
Availability	Finland ( <i>n</i> 925)	0.02*	0.00-0.04
Facilitation	Norway ( <i>n</i> 464)	0.03*	0.00-0.06
Liking	Norway ( <i>n</i> 464)	0.08***	0.05-0.12
Self-efficacy	Portugal ( <i>n</i> 776)	0.05**	0.01-0.09
Knowledge	Greece ( <i>n</i> 703)	0.04*	0.01-0.07
	Portugal ( <i>n</i> 776)	0.05***	0.02-0.07

B = unstandardized regression coefficient, CI = confidence interval

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

† Mediated effect (path a x b) is the indirect effect between parental educational level and children's daily fruit intake. All analyses were adjusted for children's age and gender.

The mediated effects between PEL and children's daily vegetable intake are shown in Table 5. Availability of vegetables at home was a significant mediator in Finland, Germany and Iceland, liking for vegetables in Finland, self-efficacy to eat vegetables in Norway and knowledge of the recommendations in Greece, Iceland and Portugal.

**Table 5.** The mediated effects<sup>†</sup> between parental educational level and children's daily vegetable intake in different countries arranged by statistically-significant mediators.<sup>‡</sup>

		B	95% CI
Availability	Finland ( <i>n</i> 925)	0.06***	0.02-0.10
	Germany ( <i>n</i> 615)	0.04*	0.00-0.08
	Iceland ( <i>n</i> 386)	0.09*	0.01-0.16
Liking	Finland ( <i>n</i> 925)	0.03*	0.00-0.05
Self-efficacy	Norway ( <i>n</i> 464)	0.04*	0.01-0.07
Knowledge	Greece ( <i>n</i> 703)	0.03*	0.00-0.07
	Iceland ( <i>n</i> 386)	0.07*	0.02-0.13
	Portugal ( <i>n</i> 776)	0.06*	0.01-0.12

B = unstandardized regression coefficient, CI = confidence interval

\*  $p < 0.05$ , \*\*\*  $p < 0.001$

† Mediated effect (path  $a \times b$ ) is the indirect effect between parental educational level and children's daily vegetable intake.

All analyses were adjusted for children's age and gender.

### 5.3 THE EFFECT OF DESCRIPTIVE NORMS ON CHILDREN'S FRUIT AND VEGETABLE INTAKE

Fruit intake was higher among girls at baseline but since girls' fruit intake decreased more during the study year, no gender differences in fruit intake were noted in the follow-up. Girls' vegetable intake was higher both at baseline and in the follow-up. Girls also reported higher perceived fruit intake among friends at baseline.

Table 6 shows the associations between perceived fruit intake of mother, father and friends at baseline and children's own fruit intake at baseline, in the follow-up and the change in the fruit intake from baseline to the follow-up. Perceived fruit intake of mother, father and friends were similarly associated with children's fruit intake at baseline and also predicted children's fruit intake in the follow-up. The impact of mother was stronger among boys in the case of baseline fruit intake but for the change in fruit intake descriptive norms had no impact either among girls or boys.



**Table 6.** Standardized regression coefficients ( $\beta$ ) and 95% confidence intervals (CI 95%) from linear regression analyses for predicting children's fruit intake at baseline and in the follow-up by perceived fruit intake of mother, father or friends at baseline<sup>‡</sup>.

	Children's fruit intake					
	Baseline		Follow-up		Change	
	n	$\beta$ (CI 95%)	n	$\beta$ (CI 95%)	n	$\beta$ (CI 95%)
Fruit intake of mother	393	0.25*** (0.17-0.34)	396	0.15** (0.04-0.25)	390	0.03 (-0.07-0.13)
Girls <sup>†</sup>	195	0.15* (0.04-0.27)				
Boys <sup>†</sup>	198	0.37*** (0.26-0.47)				
Fruit intake of father	386	0.20*** (0.11-0.29)	390	0.24*** (0.15-0.34)	384	0.16*** (0.07-0.28)
Fruit intake of friends	391	0.17** (0.04-0.29)	394	0.19*** (0.12-0.26)	388	0.12*** (0.05-0.19)

\*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

<sup>†</sup> The associations between fruit intake of mother and children's fruit intake are shown also separately for girls and boys due to a statistically significant interaction at level  $p < 0.10$ .

<sup>‡</sup> All descriptive norm factors are studied in separate models.

All models were adjusted for gender, age and educational level of the respondent parent.

The results for the analyses examining children's vegetable intake are presented in Table 7. A higher level of perceived vegetable intake of mother, father and friends was associated with a higher vegetable intake among children at baseline and also predicted higher vegetable intake in the follow-up. The change in children's vegetable intake was predicted only by perceived vegetable intake of father and friends. In the importance of perceived vegetable intake of mother, father and friends on children's vegetable intake, no gender differences were noted.

**Table 7.** Standardized regression coefficients ( $\beta$ ) and 95% confidence intervals (CI 95%) from linear regression analyses for predicting children's vegetable intake at baseline and follow-up by perceived vegetable intake of mother, father or friends at baseline<sup>‡</sup>.

	Children's vegetable intake					
	Baseline		Follow-up		Change	
	n	$\beta$ (CI 95%)	N	$\beta$ (CI 95%)	n	$\beta$ (CI 95%)
Vegetable intake of mother	391	0.12 <sup>*</sup> (0.02-0.23)	390	0.13 <sup>*</sup> (0.03-0.22)	382	0.06 (-0.02-0.15)
Vegetable intake of father	381	0.19 <sup>**</sup> (0.07-0.30)	382	0.22 <sup>***</sup> (0.14-0.31)	374	0.14 <sup>**</sup> (0.05-0.22)
Vegetable intake of friends	392	0.14 <sup>*</sup> (0.01-0.27)	390	0.18 <sup>***</sup> (0.07-0.28)	382	0.11 <sup>*</sup> (0.01-0.20)

<sup>\*</sup>  $p < 0.05$ ; <sup>\*\*</sup>  $p < 0.01$ ; <sup>\*\*\*</sup>  $p < 0.001$

<sup>‡</sup> All descriptive norm factors are studied in separate models.

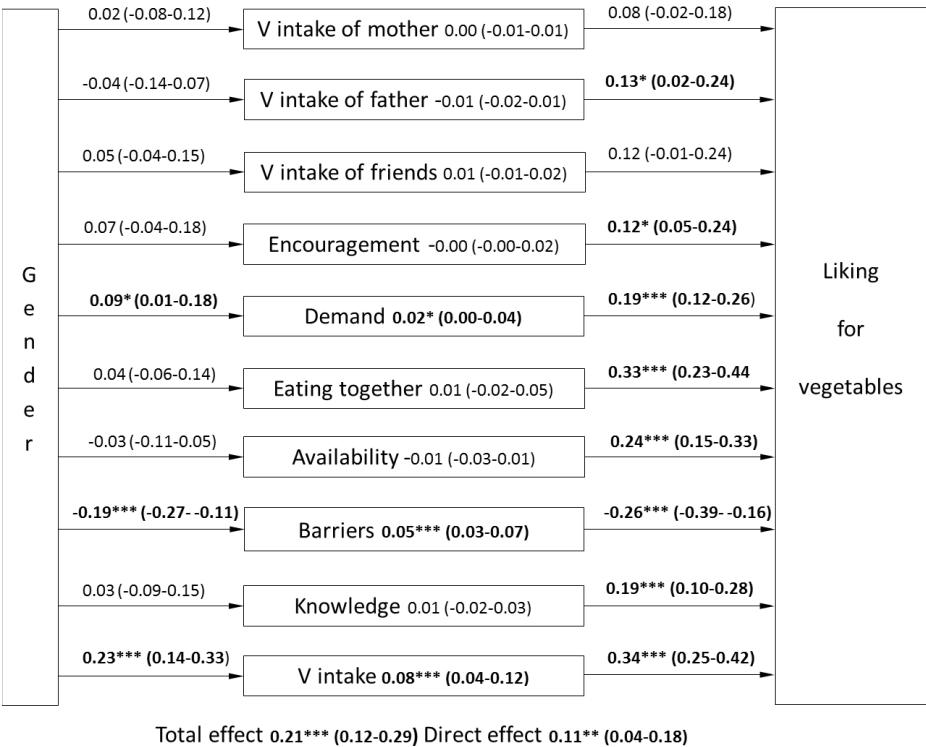
All models were adjusted for gender, age and educational level of the respondent parent.

## 5.4 GENDER DIFFERENCES IN LIKING FOR VEGETABLES AND IN PREFERENCES FOR A VARIETY OF VEGETABLES

As shown in Table 3, no gender differences in liking for vegetables were found at baseline, but during the follow-up boys' liking for vegetables decreased more than was the case among girls. As a result, girls scored higher in liking than did boys in the follow-up. A similar pattern was noted with preferences for a variety of vegetables: at baseline no gender differences were present, but in the follow-up girls reported a higher level in the preferences for a variety of vegetables.

The coefficients for the mediation model explaining gender differences in liking are shown in the Figure 10. Girls reported that their parents demand them to eat vegetables more often than did boys. Girls also perceived fewer barriers to eat vegetables and had higher vegetable intake than did boys. Higher liking for vegetables was predicted by higher levels of perceived vegetable intake of father, parental encouragement, parental demand to eat vegetables, eating vegetables together with the family, availability of vegetables at home, children's knowledge of the recommendations, previous vegetable intake and fewer perceived barriers. When each mediator was examined in separate models, gender differences in liking for vegetables were partly explained by girls' higher

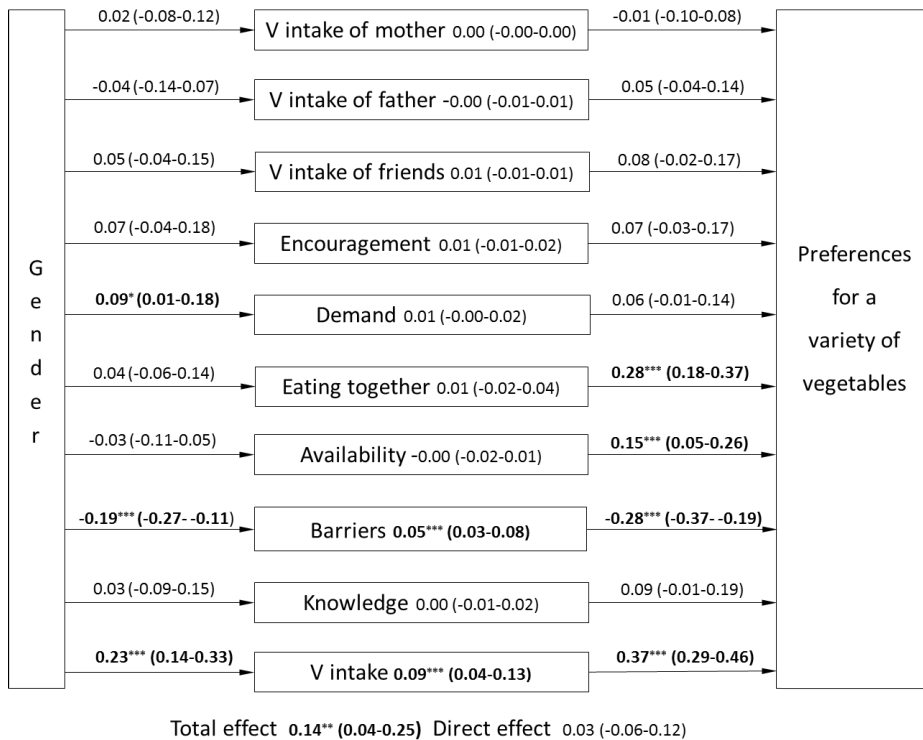
previous vegetable intake, more frequent parental demands to eat vegetables and lower level of perceived barriers. A model where all mediators were examined simultaneously (data not shown), only previous vegetable intake ( $\beta = 0.05^{**}$ , 95% CI = 0.02–0.09) and perceived barriers ( $\beta = 0.03^{**}$ , 95% CI = 0.02–0.05) acted as significant mediators.



**FIGURE 10.** Mediation model with standardized regression coefficients and 95% confidence intervals explaining gender differences in liking for vegetables. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

The coefficients for the mediation model explaining gender differences in preferences for a variety of vegetables are shown in the Figure 11. Higher preferences for a variety of vegetables was predicted by having fewer brothers, higher levels of eating vegetables together with the family, availability of vegetables at home, previous vegetable intake and fewer perceived barriers. Gender differences in the preferences for a variety of vegetables were partly

explained by girls' higher previous vegetable intake and lower level of perceived barriers in the models where each mediator was examined separately. The results were also similar in the model where all mediators were simultaneously included (data not shown): higher level of preferences for a variety of vegetables among girls was partly explained by girls' higher previous vegetable intake ( $\beta = 0.08^{**}$ , 95% CI = 0.04–0.12) and fewer perceived barriers ( $\beta = 0.04^{**}$ , 95% CI = 0.02–0.07).



**FIGURE 11.** Mediation model with standardized regression coefficients and 95% confidence intervals explaining gender differences in preferences for a variety of vegetables. \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

## 5.5 THE EFFECT OF THE INTERVENTION ON THE CHANGE IN CHILDREN'S FRUIT AND VEGETABLE INTAKE

Intervention schools were dichotomized to a group in which the implementation level was low and to a group with a high level of implementation. The characteristics of the variables are presented separately for control schools, interventions schools with low level of implementation and high level of implementation in Table 8. In control schools, children's liking for FV decreased and attitudes for FV became less favourable during the follow-up. Only preferences for a variety of vegetables increased in control schools. In the group of low implementation level, the only change was that children's attitudes became less favourable for fruits. In the group of high implementation level, availability of fruits increased, indicating that children started to bring fruit to school to be eaten as a snack more often. In addition, children's knowledge of the recommendations increased in the group of high implementation level.

**Table 8.** Means and standard deviations (SD) at baseline, in the follow-up and the change between those, presented separately for control schools, intervention schools with low level of implementation (Low) and intervention schools with high level of implementation (High).

	Control (n=424)	Intervention Low (n=130)      High (n=173)	
	Mean (SD)		
Determinants of fruit intake			
Availability <sup>†</sup> , B	2.43 (1.03)	2.43 (1.10)	2.30 (1.02)
Availability, F-U	2.25 (1.00)	2.50 (1.17)	2.62 (1.15)
Availability, change	-0.19 (0.96)	0.06 (1.08)	<b>0.33*** (1.01)</b>
Liking <sup>‡</sup> , B	4.45 (0.66)	4.36 (0.81)	4.39 (0.75)
Liking, F-U	4.37 (0.77)	4.30 (0.79)	4.38 (0.70)
Liking, change	<b>-0.09* (0.71)</b>	-0.06 (0.71)	-0.01 (0.79)
Preferences <sup>‡</sup> , B	1.35 (0.54)	1.36 (0.57)	1.43 (0.47)
Preferences, F-U	1.39 (0.54)	1.38 (0.59)	1.43 (0.46)
Preferences, change	0.03 (0.43)	0.03 (0.36)	0.00 (0.34)
Attitudes <sup>‡</sup> , B	4.19 (0.77)	4.14 (0.81)	4.01 (0.93)
Attitudes, F-U	4.09 (0.85)	3.92 (1.04)	4.02 (0.79)
Attitudes, change	<b>-0.12** (0.89)</b>	<b>-0.23** (1.02)</b>	0.01 (0.97)
Self-efficacy <sup>‡</sup> , B	4.18 (0.80)	4.15 (0.86)	4.12 (0.96)
Self-efficacy, F-U	4.24 (0.82)	4.22 (0.88)	4.24 (0.81)
Self-efficacy, change	0.06 (0.90)	0.06 (0.97)	0.12 (0.99)
Determinants of vegetable intake			
Availability <sup>†</sup> , B	1.87 (0.89)	1.75 (0.95)	1.72 (0.86)
Availability, F-U	1.70 (0.84)	1.89 (1.05)	1.76 (0.90)
Availability, change	-0.17 (0.92)	0.12 (1.13)	0.02 (0.91)
Liking <sup>‡</sup> , B	3.83 (1.00)	3.66 (1.02)	3.49 (1.23)
Liking, F-U	3.59 (1.10)	3.56 (1.02)	3.50 (1.17)
Liking, change	<b>-0.24*** (0.94)</b>	-0.11 (0.99)	0.01 (1.08)
Preferences <sup>‡</sup> , B	0.42 (0.78)	0.49 (0.71)	0.52 (0.78)
Preferences, F-U	0.48 (0.78)	0.46 (0.77)	0.44 (0.77)
Preferences, change	<b>0.04** (0.59)</b>	-0.01(0.57)	-0.08(0.51)
Attitudes <sup>‡</sup> , B	3.94 (0.91)	3.75 (1.04)	3.51 (1.02)
Attitudes, F-U	3.71 (1.02)	3.59 (1.19)	3.49 (1.09)
Attitudes, change	<b>-0.23*** (1.02)</b>	-0.18(1.19)	0.00 (1.11)
Self-efficacy <sup>‡</sup> , B	3.89 (0.96)	3.92 (1.00)	3.65 (1.06)
Self-efficacy, F-U	3.92 (0.98)	3.88 (0.96)	3.83 (1.05)
Self-efficacy, change	0.03 (1.02)	-0.01 (1.07)	0.18 (1.16)
Knowledge of recommendations %			
Decrease from B to F-U	48	34	21
Same at B and in the F-U*	9	10	4
Increase from B to F-U*	17	18	23
5 per day at F-U	26	38	52

B=baseline; F-U=follow-up

<sup>†</sup> Range between 0–5; <sup>‡</sup> Range between -2–2

Change between baseline and follow-up is indicated by the level of significance \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$

The frequencies of children’s weekly fruit and vegetable intake at baseline and in the follow-up are presented in Figure 12 separately for control schools, intervention schools with low level of implementation and intervention schools with high level of implementation. There was a positive change in children’s fruit intake only in the group of high implementation from baseline to the follow-up. Significant changes in vegetable intake were not found in any of the intervention groups or among children in control schools.

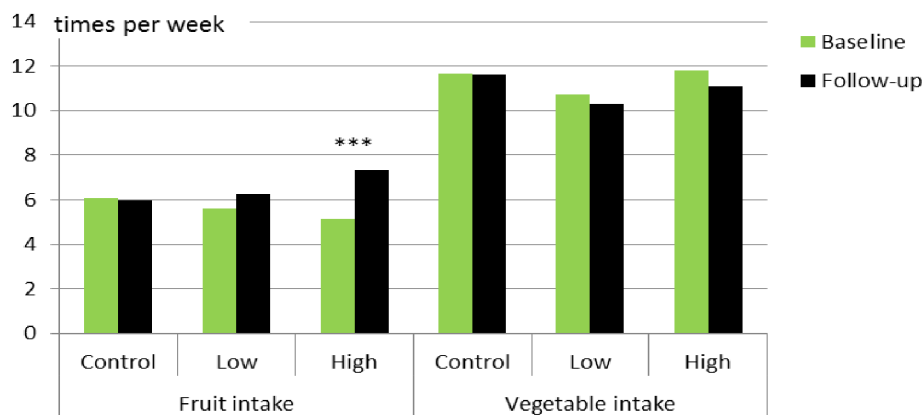


FIGURE 12. Changes in children’s fruit and vegetable intake shown separately for control schools, intervention schools divided to low level of implementation and high level of implementation. The statistically significant change from baseline to follow-up is indicated with \*\*\* $p < 0.001$ .

Table 9 shows the total and direct effects of the intervention on the change in children’s fruit and vegetable intake derived from the mediation analyses. Total effect on children’s fruit intake of the intervention was noted only in the group of high implementation level. When controlling for the mediators, this impact became non-significant (direct effect). Lower level of implementation yielded no increase in fruit intake. Intervention had no effect on vegetable intake, whether it was implemented on a high or low level.

**Table 9.** Unstandardized regression coefficients and 95% confidence intervals for the total and direct effect of the implementation level of the intervention on the change in children's fruit and vegetable intake frequency.

		Total effect		Direct effect	
		$\beta$	95% CI	$\beta$	95% CI
Fruit intake					
	High implementation level	1.89*	0.26–3.52	0.78	-0.51–2.06
	Low implementation level	0.64	-0.43–1.71	0.12	-0.78–1.01
Vegetable intake					
	High implementation level	-0.07	-2.03–1.90	-1.20	-3.08–0.68
	Low implementation level	0.65	-0.87–2.17	0.14	-1.19–1.47

The significance of change compared to the control group is indicated with \* $p < 0.05$ .  
All models were adjusted for children's gender.

Table 10 presents the intervention effects on mediators (path a), the impact of the change in mediators on the change in children's fruit and vegetable intake (paths b) and the mediated or indirect effects of the intervention (path a x b). Intervention increased the frequency of taking fruits to school (availability) and children's knowledge of the recommendations in both intervention groups. In addition, if the intervention was implemented on a higher level, children's liking for fruits also increased. Increase in taking fruit to school, liking for fruits and knowledge of the recommendations were positively associated with the change in fruit intake. Intervention increased fruit intake by increasing children's frequency to take fruit to school in the intervention group of low implementation level. In the group of high implementation level, fruit intake increased due to increased liking for fruits and knowledge of the recommendations. Similar to the analyses with fruit intake, increase in knowledge was positively associated with the increase in children's vegetable intake. Increase in knowledge mediated the intervention effect on vegetable intake, both in the group of low implementation and high implementation level.



**Table 10.** Unstandardized regression coefficients and 95% confidence intervals (CI) for the impact of intervention (low level of implementation and high level of implementation) on the relevant mediators (path a), for the impact of change in relevant mediators on outcomes (path b) and the implementation of the intervention on the change in children's fruit and vegetable intake frequency (path a x b).

	Path a		Path b		Path a x b	
	$\beta$	95% CI	$\beta$	95% CI	$\beta$	95% CI
Fruit intake						
Availability			0.87***	0.32–0.86		
High implementation	0.48*	0.04–0.92			0.42	-0.11–0.94
Low implementation	0.31*	0.07–0.56			0.27*	0.02–0.52
Liking			1.07***	0.72–1.42		
High implementation	0.15*	0.01–0.29			0.16*	0.02–0.30
Low implementation	0.01	-0.17–0.18			0.01	-0.18–0.19
Knowledge			0.60***	0.33–0.86		
High implementation	0.91***	0.61–1.20			0.54**	0.21–0.54
Low implementation	0.41*	0.03–0.78			0.24	-0.03–0.24
Vegetable intake						
Knowledge			1.27***	0.78–1.76		
High implementation	0.90***	0.60–1.19			1.14***	0.53–1.74
Low implementation	0.40*	0.04–0.77			0.51*	0.01–1.02

The significance of change compared to the control group is indicated with \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ .  
All models were adjusted for children's gender.

## 6 DISCUSSION

The aim of the present study was to examine the role of psychosocial factors in explaining socioeconomic and gender differences in children's FV intake, in one of its main predictors, preferences, and in the intervention effect on children's FV intake. The findings add to the knowledge in this field by clarifying the possible paths for differences in FV intake and hence, enable better targeting of future interventions. The main findings can be roughly presented from four angles. First, in most of the examined ten European countries, children with lower socioeconomic background were likely to have lower FV intake. Factors which could explain these associations differed across the countries but the most significant mediators were availability of FV at home and children's knowledge of the recommendations regarding sufficient daily FV intake. Second, among 11-year olds descriptive norms were equally important for girls and boys whether they were related to perceived maternal, paternal or friends' FV intake. Higher perceived FV intake of mothers, fathers and friends also predicted children's higher FV intake in the longitudinal setting and only mother's FV intake lost its predictive power when explaining the change in children's FV intake. Third, girls' higher liking for vegetables and higher preferences for a variety of vegetables were partly explained by girls' higher previous vegetable intake and lower level of perceived barriers to eat vegetables. In addition, higher liking for vegetables among girls could be partly attributed to the higher level of parental demand to eat vegetables reported by girls. Fourth, if the implementation level was low, intervention increased fruit intake only by increasing the frequency that children took fruits to school to be eaten as a snack. However, when the intervention was implemented on a higher level, increase in children's fruit intake was reached via children's increased liking for fruits and increased knowledge of the recommendations. Increase in fruit intake was greater in the group of high implementation compared to the group with low implementation level. Still, regarding children's vegetable intake no intervention effect was found whether the implementation level was low or high. These findings are next presented and discussed in detail in relation to previous research.

### 6.1 MAIN FINDINGS AND THEIR INTERPRETATIONS

Many studies have not examined fruit intake and vegetable intake as separate

outcomes. Hence in relation to previous research, the results of the present study are discussed as combined FV intake if no explicit differences between fruit intake and vegetable intake – or factors related to them – were noted. The discussion of the main findings is roughly divided according to the topics of Studies I–IV but comparisons between the results of these four studies are also included in each section.

### **Fruit and vegetable intake and socioeconomic status**

Higher parental educational level was associated with higher FV intake among children in most, but not all, European countries. SES differences in children's FV intake have previously been reported in some European countries, such as Norway (Nilsen et al. 2010) and Sweden (Säfsten et al. 2015), although not all studies have found a SES gradient. There is by no means accordance between results derived from same countries indicating that the differences in the results can be due to differences in the participants' age, study area, measures or the cut off points in the measures. In Finland, for example, SES differences in 6–8 year old children's FV intake were not found in a study which had the cut-off point of FV intake in less than three portions daily versus at least three portions of FV daily (Eloranta et al. 2011). In PRO GREENS, the participants were approximately 11-years old and children with higher PEL were more likely to eat vegetables daily but no PEL differences in fruit intake frequency were noted. In a national report (Kaikkonen et al. 2012), however, lower PEL has been associated with lower FV intake.

Across-country comparisons are somewhat challenging due to differences in the socioeconomic structure and food culture, which is closely intertwined with the availability and affordability of food items such as FV. It has been reported that in Greece, for example, fresh vegetables are consumed more often in households with low educational and income level (Trichopoulou et al. 2002). As researchers have pointed out, that might reflect the adherence to the traditional diet among the ones with lower education and income (Trichopoulou et al. 2002), but it can also be due to the differences in the relative prices of such food items as FV (Eurostat 2016). Similar to Study I, the IDEFICS study, which was conducted in several European countries among 2- to 9-year olds, generally demonstrated lower FV intake frequencies among children with lower PEL (Fernández-Alvira et al. 2013). There was, however, a great variance in the significance of the PEL differences, since they were not necessarily found in all countries, between each (low, middle and high) PEL group or they were found

for fruit intake but not for vegetable intake or the other way around (Fernández-Alvira et al. 2013). Even though the PEL gradient was not significant in all countries participating in Study I, it should be noted that the trend of higher PEL being associated with the likelihood of daily FV intake was seen in all countries and for both fruit and vegetable intake with only one exception (fruit intake in Slovenia). This indicates that if more sensitive measures compared to dichotomized PEL and FV intake would be used, lower FV intake among children with lower PEL could be more evident.

The most important psychosocial and environmental factors that mediated the association between PEL and children's FV intake were availability of FV at home and children's knowledge of the recommendations. Self-efficacy to eat FV and liking for FV were also significant mediators in some countries for both fruit and vegetable intake and facilitation by parents only for fruit intake. Children's self-efficacy was a significant mediator in Norway and Portugal, the same countries where the reliability of the construct was very low. This indicates that these results should be interpreted with caution due to the ambivalence of the self-efficacy construct. Similar to our findings, accessibility, a construct combining both availability of FV at home and aspects of facilitation of FV intake, has been found to partly explain SES differences in children's FV intake in Norway (Bere et al. 2008, Hilsen et al. 2011). In Study I, parental influence was not as directly assessed as it has been in a study which found parent's own fruit intake to partly explain higher fruit intake among children with higher PEL (Rodenburg et al. 2013). In addition to home availability of FV and parental FV intake, parental rules about eating FV intake have also been identified to mediate the association between PEL and children's FV intake (van Ansem et al. 2013). Acknowledging the importance of home FV availability on children's FV intake (Blanchette and Brug 2005), its role in explaining PEL differences in FV intake seems to deserve more attention as well. Thereby one must consider its close relation to knowledge of the recommendations concerning FV intake.

The strong position of knowledge as a mediator in most examined countries is somewhat surprising, since knowledge is not recognized as one of the most important predictors of FV intake (Blanchette and Brug 2005). Nor was high knowledge the strongest associate of children's daily FV intake in the present study, but since better knowledge was often associated with high PEL, the mediation path became significant. It is probable that poorer knowledge of the FV recommendation among less educated mothers (Vereecken and Maes 2010) can be passed on to their children. It can only be hypothesized whether children's knowledge is a real mediator between their PEL and FV intake per se

or more likely a variable which reflects parental knowledge and the way they speak about food with their children and thus, pass on their values and attitudes. Among adults, knowledge of the recommendations has often been associated with FV intake (Shaikh et al. 2008). Moreover, parental knowledge has been found to have an important role in determining FV availability for children. Among Australian mothers of 5–12-year old children, the home availability mediated the association between maternal nutrition knowledge and children's FV intake (Campbell et al. 2013). When the aim is to increase low FV intake among children with low PEL, one option might be to increase the knowledge of the parents, which would increase home availability of FV, and thus, influence positively children's FV intake.

Overall, there were also notable country differences in the importance of the mediating factors but a clear pattern of, for example, a south–north gradient was not found (data not shown). In a descriptive study as ours, more detailed analyses which would take into account the differences in food cultures and school-lunch policies could not be made. The across-country differences are an important issue, since they affect the construction of future interventions. To be effective, intervention should target the most relevant, changeable determinants of children's FV intake. As such, knowledge is a potential factor to be targeted due to its cost-effectiveness compared to, for example, the costs of increasing availability by distributing FV to children at school. Still, a high implementation level of an intervention is required to achieve an increase in children's knowledge about the role of FV in a healthy diet, as was shown in Study IV. In addition, Study IV showed that an increase in knowledge is not necessarily a sufficient prerequisite to increase children's vegetable intake. However, there are also examples of interventions which have increased children's FV intake by increasing children's knowledge (Reynolds et al. 2004).

### **Fruit and vegetable intake and descriptive norms**

Among Finnish children, positive descriptive norms about FV intake of their mothers, fathers and friends were associated with their own high FV intake and also predicted children's higher FV intake one year later. With one exception which is discussed later, descriptive norms were similarly important for both girls and boys and whether they implied to mother, father or friends. When predicting the change in children's FV intake, descriptive norms concerning mother's FV intake lost its predictive power. The strong emphasis on descriptive norms related to the friends, in comparison to those of the parents, is somewhat

in contrast with another recent study where the parental impact was stronger (Pedersen et al. 2015). This might be due to the different importance of more distant peers in the Danish study (Pedersen et al. 2015) versus best friends in our study. In addition, dissimilarities in the importance of parents versus friends/peers can be attributed to school lunch policies. It has been noted that parental descriptive norms, eating vegetables with the family and parental demand all had stronger associations with children's FV intake in countries where no free school-lunch was provided. Comparatively, lower associations were evident for the countries where children shared a common meal each school day with their friends and peers. (Ray et al. 2012.) Another explanation for the lack of importance of the peer influence could be the inclusion of children's outcome expectancies in the same model with parental and peer descriptive norms, which was not done in the present study. In a study where parental influence was not examined, peer related descriptive (but not prescriptive) norms were positively associated with 16–17-year olds FV intake (Lally et al. 2011). This indicates that, in absence of further analyses, cautious acknowledgement of the importance of peer- and friend-related descriptive norms on children's FV intake can be made.

No gender-specific effect of descriptive norms was noted, which was in accordance with the Danish study (Pedersen et al. 2015) but differed from the results of studies conducted in Finland (Talvia et al. 2006) and Iceland (Kristjansdottir et al. 2006). Among Icelandic girls descriptive norm, conceptualized as the perception of FV intake of mother, father and friends, was associated with FV intake but among boys that relation was non-significant (Kristjansdottir et al. 2006). The Finnish study reported a correspondence in FV intake between mothers and both daughters and sons, whereas FV intake of fathers correlated only with their sons' FV intake (Talvia et al. 2006). In the present study, the only interaction that was noted was the stronger association between fruit intake of mothers and their sons compared to their daughters. This effect was not present in the longitudinal analyses, which can be a sign of diminishing importance of the mother as a role model when boys grow older. Without more specific analyses and longer follow-ups, however, very far reaching interpretations cannot be made. The lack of gender differences in the descriptive norms on children's FV intake is an important issue regarding interventions, since it implies that both girls and boys are similarly prone to the influences of their social environment, and would probably also respond to the changes in it. Since adolescents have been shown to under-estimate their peers' FV intake – and that this inaccurate perception of low FV intake among peers is associated with their own FV intake – (Lally et al. 2011), correcting descriptive

norms to more positive ones might prove to be one tool to be used in interventions. Descriptive norms have been found to positively impact FV intake even though they are not related to real people with whom one is closely related. An experimental study that informed adolescents about fruit intake of their peers via short text that the participants read increased both adolescents' intention to eat fruits and the actual fruit intake (Stok et al. 2014). Similarly, FV intake increased among smaller children during an intervention which presented children videos of heroic but imaginary peers consuming FV (Horne et al. 2004).

The results of Study II showing the importance of descriptive norms related to friends on children's FV intake also raise the question of the significance of the social environment in forming SES differences in FV intake. If the lower socioeconomic background is manifesting in children's lower FV intake and the child is having the same role models from other children due to areal SES differences and selection of the low SES children to the same school, this would mean a cumulative effect of SES on children's FV intake. Higher school-level SES, which was conceptualized as more pupils with higher parental occupational level in the same school, was found to be associated with children's higher fruit intake in a European sample of 11-, 13- and 15-year-olds (Vereecken et al. 2005). The impact of school-level SES was seen even though the parental occupational level and material wealth of the family were included in the same model. To the best of my knowledge, similar research about school-level segregation and its influences on children's FV intake has not been conducted in Finland. Future interventions targeting low SES children could, however, also take into account SES of the living environment and friends/peers when examining the SES-related factors the child is influenced by.

### **Gender differences in preferences for vegetables**

Although a higher liking for vegetables has more often been reported among girls than among boys (Rasmussen et al. 2006), knowledge is scarce regarding the factors promoting this gender difference. Girls in Study III also reported higher liking for vegetables and additionally greater preferences for a variety of vegetables. These gender differences in liking or preference variety were not present at baseline but evolved during the follow-up, when children were at 6<sup>th</sup> grade. Among 11-year olds in Iceland, girls have shown to score higher than boys in both liking for FV and preferences for a variety of fruits but not of vegetables (Kristjansdottir et al. 2006). In the present study, gender differences in liking

and preference variety could be partly explained by girl's higher previous vegetable intake and their lower level of perceived barriers for vegetable intake. Girls' higher liking for vegetables could also be partly due to girls' higher perception of parental demand that they should eat vegetables. The mediating effect of previous vegetable intake is not surprising since girls often have higher FV intake (Vereecken et al. 2015) and FV intake is known to be a significant predictor of liking for FV (Tak et al. 2008). The mediating effect of perceived barriers is more complex, since barriers was a sum variable including aspects such as 'not eating vegetables since one is still hungry after having eaten them' or since one wants to eat something else. Contradictory to Study III, in the Pro Children study, an almost-identically-constructed variable was not associated with children's FV intake in any of the nine participating countries (De Bourdeaudhuij et al. 2008). The lack of association in the Pro Children study can be postulated to be due to the inclusion of several other similar factors, such as attitudes, in the same model. The main difference to the above-mentioned study, however, was that Study III predicted children's liking and preferences, not the actual vegetable intake. Gender difference in the importance of perceived barriers indicates that boys attribute different meanings and demands for the food they consider edible. Vegetables include many essential vitamins and minerals, but are low in energy so they fail to create an instant feeling of satiety. It can only be hypothesized, whether boys' liking for vegetables and, further on, vegetable intake could be increased by extending their view about food being mainly an energy supplier to include also a wider nourishment perspective.

Preference for a variety of vegetables have seldom drawn focus in studies examining liking for FV or food preferences in general. In the present study, the predictors for preference variety were somewhat different than for liking for vegetables. Descriptive norms, parental encouragement or demands and knowledge of the recommendations, which predicted liking, had no effect on children's preference variety. On the other hand, the factors that predicted both liking for vegetables and preferences for a variety of vegetables were previous vegetable intake, eating vegetables together with the family, perceiving fewer barriers for vegetable intake and having vegetables available at home. On the contrary to the non-significant effect on liking, also having brothers had a weak but still significant negative effect on preference variety. The only study which has examined a similar topic, even remotely, found that having siblings negatively affected infants' vegetable intake (Koh et al. 2014). Especially because the effect of having brothers was small, no far reaching interpretations can be made. Still, it is possible that having children with low level of preference variety



around the same table can negatively affect the variety of vegetables that are provided to the children, which prohibits children from developing their preferences for a variety of vegetables.

The importance of the parents cannot be understated when considering the influences that form preferences for a variety of vegetables, since children learn to like the taste of FV by being exposed to the same taste repeatedly (Anzman-Frasca et al. 2012, Caton et al. 2013). In the present study, this was reflected by the strong influence of eating vegetables together with the family as well as previous vegetable intake on the preference variety. The lack of the impact of parental descriptive norms, encouragement or demands can be interpreted to reflect the internalizing process of preference variety which probably has its basis set up already in early childhood. It is also likely that the variety of different vegetables available and provided at home is relatively stable and a result of parental preferences. It has been noted that the sorts of food children had never tasted at the age of 8-years were often the same foods their mothers disliked (Skinner et al. 2002). In the present study, the non-significance of parental descriptive norms, encouragement or demands on children's preference variety can also be tracked to the used measures, since the above-mentioned constructs were not asked specifically related to the variety of vegetables. This means that the wording for the question assessing parental demand, for example, was 'Do your parents demand that you eat vegetables every day?' instead of 'Do your parents demand that you eat *a variety of* vegetables every day?' The variety of different vegetables occurred explicitly only in the question assessing home vegetable availability, which significantly predicted children's preference variety. Some attention should be drawn to the role of children's knowledge of the recommendations which predicted children's liking for vegetables but not preferences for a variety of vegetables. The nutritional recommendations as well as familiar campaigns such as "5 a day" promoting an adequate FV intake have more explicitly stressed, until recently, the amount and not the variety of FV that should be included in the diet (see e.g. The National Nutrition Council 1998, freshfel 2016). Therefore, it can be that parents have put less effort in getting their children to "eat a rainbow" as the variety of vegetables in different colours is currently often expressed in campaigns which aim not only to increase children's FV intake but, moreover, the variety in it (see e.g. Fruits & Veggies - More Matters 2016).

## **Intervention effect on fruit and vegetable intake**

Most of the intervention studies reviewed by Stralen et al. (2011) were unable to change the determinants of FV intake and therefore lacked the effectiveness to increase FV intake. In Study IV, a school-based, multicomponent intervention was successful in increasing children's fruit intake by increasing children's knowledge of the recommendations, liking for fruits and the frequency that children took fruit to school to be eaten as a snack. Only the positive change in children's knowledge mediated the intervention effect on the increase in vegetable intake even though an overall effect of the intervention on children's vegetable intake was not noted. Similar to our results, a school-based nutrition education intervention in Scotland could increase children's preferences for FV and also yielded an increase in fruit intake but not in vegetable intake (Anderson et al. 2005). The difficulty in increasing vegetable intake has been demonstrated in other intervention studies as well (Evans et al. 2012). The reasons for achieving an increase in fruit intake, but not in vegetable intake, can be attributed to many factors: normally fruits are not provided in Finnish schools, fruits might be seen as more suitable for snacks and fruits are more preferred than are vegetables. For both adults (Glasson et al. 2011) and children (Reinaerts et al. 2007) applies that eating fruits and eating vegetables are different behaviours which have partly different predictors and barriers and would because of that demand different kinds of intervention.

Similar to Study I, in Study IV the role of knowledge was quite strong in mediating the intervention effect on both fruit intake and vegetable intake. One hypothesis is that knowledge was the easiest factor to be influenced in a short time period. A previous intervention study reported increase in children's FV intake that was reached via increasing knowledge (Reynolds et al. 2004). The intervention effect of increased FV intake, however, faded after a year (Reynolds et al. 2004). This implies that future interventions should be constructed to be longer lasting – possibly embedded in the school curriculum – in order to have effect on other relevant determinants of FV intake, such as liking and preferences. Based on their review, which was published over a decade ago, Knai et al. (2006) suggested that interventions should, among other components, include a duration of at least 12 months in order to increase FV intake among children. A long duration and a demanding protocol can, however, be a burden for the teachers responsible for the implementation and thus become a barrier for a proper implementation (Jørgensen et al. 2014). Other propositions, based on the review, were that interventions should be implemented in a way that they increase children's exposure to FV and involve parents both at home and at

school (Knai et al. 2006). In Study IV, the intensity of parental participation was not measured as part of the implementation level. The only indicator which can be seen to reflect parental participation is the provision of FV, which children took with them to school to be eaten as a snack. However, since participating children were over 11-years old, it is possible that at least among some of them, no parental contribution was needed but children were able to pack FV in their schoolbag on their own. Independent initiatives would require high self-efficacy from the child, which was not affected by the intervention but still predicted change in FV intake.

## 6.2 METHODOLOGICAL CONSIDERATIONS

The present thesis adds to the knowledge of the reasons behind the well documented gender and SES differences in children's FV intake or its predictors. Few studies have investigated the mediation and moderation models with gender or SES in connection with different psychosocial factors and children's FV intake (for SES, see Bere et al. 2008, Hilsen et al. 2011, Rodenburg et al. 2013 and for gender, see Bere et al. 2008). Additional value has been gained by using longitudinal study design in Studies II–IV and a European-level approach in Study I. The study protocol and questionnaires used in Study I were similar in each participating country, which enables the across-country comparison of the results. The country differences in the relevance of the mediators between PEL and children's FV, stresses the importance of considering the local and population-specific determinants to be targeted in future interventions. The questionnaires used in the PRO GREENS project had been previously validated as a part of the Pro Children study in four European countries for the measures of FV intake (Haraldsdóttir et al. 2005) and in five countries for the measures of FV-intake-related factors, which were found to have a moderate validity and reliability (De Bourdeaudhuij et al. 2005). Some of the constructs, however, had low internal consistency in some countries as shown in Appendix 1. It must be considered that the measurement of internal consistency is affected by the number of items that the construct consists of. The constructs included in the present thesis consisted of only two items at best. This is a common practise in research conducted among children, since the questionnaires would otherwise be too long and demanding. As the participating children were nested in school classes, all regression analyses were corrected for the higher group level. However, this might not have been necessary since the intra-class correlations were small and correction for the group effect did not

change the results of the regression analyses significantly. A further advantage of the Studies II–IV, which increases the reliability of the presented results, is the high response rate in Finland and also in some other countries in Study I.

There are some methodological limitations that have to be considered when the results of this thesis are interpreted. Data which was used in Study I was not nationally representative in eight out of ten participating countries, since only the Netherlands and Slovenia provided a nationally representative sample. This means that the results from countries other than the Netherlands and Slovenia do not necessarily apply to all schoolchildren of the participating countries. Finnish data used, in addition to Study I, also in Studies II–IV was derived from a Swedish speaking minority, which comprises approximately five percent of Finland's population (Statistics Finland 2013b). The Swedish-speaking adult population has been shown to have a similar educational-level distribution (Statistics Finland 2013a, Statistics Finland 2014) but to be wealthier when compared to the Finnish speaking population (Saarela 2006). Since income and wealth were not assessed in the present study, it can only be hypothesized whether SES differences in FV intake are even larger among Finnish speaking children. A national report has documented higher FV intake among children of higher educated mothers (Kaikkonen et al. 2012), but not all studies confirm this finding. Research conducted in cities with almost solely Finnish speaking population has found children with higher parental occupation to eat more vegetables but not fruits (Haapalahti et al. 2003) or no SES differences have been found (Eloranta et al. 2011). It should also be taken into consideration that in the present study only one aspect of SES was captured: the results could be somewhat different if the indicator of SES would have been, for example, income or occupation instead of parental educational level.

Another limitation of the present thesis is the measurement of children's FV intake as a general intake frequency. The measures of a frequency of FV intake fail to capture the exact amount of FV eaten since no account is made regarding variation in portion size. There is always a choice to make between more accurate and therefore more demanding measures and, on the other hand, a larger number of participants among whom only relatively simple measurements are possible due to practical reasons. Children participating in the PRO GREENS project also completed a 24-hour food diary which would provide a more detailed picture of their FV intake. Unfortunately, results of a single day cannot be used as reliable measures of a usual intake because of the large fluctuation of the diet between days (Willett 1990). When compared to objective measures, such as an observation by a trained staff member, children

have been shown to under-report their FV intake by 13% for fruits and 20% for vegetables (Harrington et al. 2009). This underestimation of FV intake in self-reports does not alter the fact that even when adding the omitted amount of FV to the reported FV intake, real FV intake would be inadequate to meet the recommendations. Although there is probably some inaccuracy in self-reported FV intake, FFQ used in the present study has been found to be an appropriate tool among 11-year-old children to rank them according to their usual FV intake (Haraldsdóttir et al. 2005).

A further problem related to measurements is the way in which the indicator of PEL was used. In order to compare the ten European countries which participated in Study I, the PEL variable had to be dichotomized in the only possible way that would dispel the differences and non-correspondences of the education system in all participating countries. This approach might have decreased the likelihood to find significant differences between the PEL groups, since it is possible that only the lowest PEL group is the most disadvantaged one which differs significantly from the higher PEL groups. The disadvantaged position of the children in the lowest SES group, compared to the middle or highest groups, has previously been demonstrated both for fruit intake (van Ansem et al. 2013, Sandvik et al. 2010) and vegetable intake (van Ansem et al. 2013).

Some remarks about the study settings, which can influence the results, should be addressed here. A cross-sectional setting in Study I is not the most preferable design to conduct mediation analyses with, since there is a danger of both over- and underestimating the strength of the results (Maxwell et al. 2011). Still, the mediation model was constructed in a way which is supported by previous research: the mediating factors have been identified as possible predictors of FV intake among schoolchildren (Rasmussen et al. 2006). Furthermore, it is obvious that PEL precedes children's FV intake and environmental and psychosocial factors associated with it and not the other way around. Even though Studies II, III and IV use a longitudinal data, the follow-up period was only one year long. Especially when development of habitual behaviours such as FV intake or liking for FV, which additionally are bidirectionally associated with each other, are of interest, longer follow-ups would be needed to correctly capture the nature of the change. Interventions aim to have a long lasting effect but a stable increase in FV intake is not easy to achieve as noted in the few studies with long follow-ups (Bere et al. 2015). On the other hand, the aim of Study IV was to identify the factors through which the implementation level affects children's FV intake and these associations are unlikely to be susceptible

to change over time. Still, it is possible that an effect achieved by some factor (e.g. increased liking for FV) would be more long-lasting than the effect which was mediated by another factor (e.g. short term increase in availability). Due to the above-mentioned limitations, the results of Studies I–IV should be interpreted with caution.

### 6.3 IMPLICATIONS FOR FUTURE RESEARCH

Based on the findings of the present study, some suggestions for future research can be made. Even though the gender and PEL differences, identified in studies I, II and III, were quite small in Finland, it is alarming that those differences exist at all, since the participating children were only 11- to 12-years old. The differences found at this age are unlikely to disappear without interventions, but may grow in tandem with the children, which will yield health inequalities later in life (Due et al. 2011). Therefore, it would be preferable to study psychosocial and environmental predictors of the maintenance of liking for FV and FV intake among even younger children. It probably would be easier to hinder the decrease in both liking for vegetables and vegetable intake, from which we caught a glimpse in the one-year follow-up, than to increase liking and intake again after the habit of eating vegetables has been interrupted. Longer follow-ups would be needed in order to illuminate the slow changes in FV intake and in liking and preferences. Thus, one could clarify the interplay of psychosocial and environmental factors that distinguish those children, whose liking and preferences decrease, from those, who continue liking and eating FV.

According to Study I, the pathway of PEL to FV intake among children is by no means explained. Even though some factors – mainly availability and knowledge – were identified as the most significant mediators, they only explained a small part of the PEL differences in FV intake. Future studies should invest in finding the relevant mediators and consider the importance of eating FV together with the family and parental descriptive norms, neither of which was included in Study I. The factors which form the development of SES differences in children's FV intake may be less related to the child but more to the parents. Eating together or descriptive norms are not separate concepts but, moreover, can be manifestations of parents' values such as the perceived importance of providing FV on meals, which might prove to be a significant mediator as well. Given the variety in the importance of PEL and different mediators on children's fruit intake and vegetable intake in different countries in Study I, in future

intervention studies it would be important to assure that the relevant mediators among the target group are identified. When the long-term goal is to diminish the inequalities in health, it is similarly crucial to identify the group with the lowest FV intake – whether the group membership is based on SES, gender, place of residence or something else. Although some critical points have been raised with relation to sub-group analyses, the need for identifying the pathways leading to health inequalities has been recognised as well (Petticrew et al. 2012).

Study II suggests that more attention should be paid on the impact that friends have on children's FV intake. Nonetheless, a Danish study has presented somewhat conflicting results identifying the greater importance of parental descriptive norms (Pedersen et al. 2015). Although it can be generally discussed whether children should be supported to become more resistant against sometimes harmful peer influence (see e.g. Houldcroft et al. 2014), it is possible to also utilize children's tendency to imitate role models. Since peer descriptive norms do not necessarily need to be related to real human beings in order to increase FV intake (Horne et al. 2004), possibilities of, for example, computer games or social media as parts of intervention studies could be considered. Until now, it is unknown whether computer-based interventions would be effective in increasing children's FV intake alone or what kind of supporting elements would be needed. Still, it would be beneficial to identify at what time do descriptive norms in relation to friends and peers become equally/more important as/than descriptive norms in relation to parents in order to target the right significant others in the interventions. Future intervention studies should ensure that the message of healthy eating received in one place is not contradicted in another place by targeting not only the child but her/his social environment at school, home and location where children spend their leisure time. This notation is supported by studies which have found that more collaboration between schools and parents has increased the effectivity of FV interventions (Blanchette and Brug 2005, Knai et al. 2006). In addition, the importance of including parents in interventions aiming to decrease the SES differences is supported by Study I, which showed home availability of FV to mediate PEL on children's FV intake.

Study IV offered some insights in the intervention effect in two different cases; when intervention was implemented on a higher or lower level. Greater increase in children's fruit intake was achieved when the intervention was implemented on a higher level compared to the lower level implementation. Moreover, the predictors of FV intake which could be changed in these two different conditions differed. By definition, all interventions aim at changing some prevailing state of affairs but the means and resources to achieve a desired change vary largely. The

present study implicates that more effort should be put in planning the interventions so that they are implementable on a high level to assure effectiveness. The persons responsible for the implementation are in a key position and hence should be highly motivated but also be provided the necessary practical tools needed for the implementation, as was discussed in focus group interviews among schoolteachers who implemented a FV intervention (Jørgensen et al. 2014). To be applicable, the interventions must be kept relatively simple and ideally focus on the most effective determinants. The question that remains unanswered is whether the intervention condition with stronger effect, i.e. the group with higher implementation level, also has a longer-lasting increase in fruit intake. If so, additional topics that should address attention are: whether the effect is stronger, since the change is reached in more determinants and thus the change is qualitatively different, or whether it is sufficient that the change is reached in specific determinants (e.g. liking) and there is no difference in the effects due to the number of changed determinants.

An important aspect to consider in future studies is the assessment of FV intake with more comprehensive measures. Even though the frequency of FV intake is a valid tool to rank children according to their general FV intake (Haraldsdóttir et al. 2005), categorization to daily versus non-daily FV intake reveals little about the actual amount of FV eaten on a certain day. Moreover, a validation of different measures according to SES and gender is an area where much more can be done. It is, for example, unclear whether the documented bias of socially-desirable responding found to be more common among adult women than among men (Hebert et al. 1995) can be seen among children as well. At least gender differences have not been found in the mean score of socially desirable responding (Baxter et al. 2004) or in reporting the amount of food eaten at lunch (Baxter et al. 1997). An American study conducted among fourth graders found no differences in the accuracy of self-reporting, which was compared with observations made by trained staff, between genders, race categories or intervention conditions for the FV intake at school-lunch (Harrington et al. 2009). Under-reporting might be more frequent and biased in intervention studies that measure food intake, which is more value-loaded and therefore susceptible for socially desirable reporting. Hence a study conducted among fifth-grade Native Americans (Harnack et al. 2004) found under-reporting in energy, total fat and saturated fatty acid intake to be more frequent among girls in the intervention condition than among girls in the control group. Among boys, such intervention effect on reporting accuracy was not noticed (Harnack et al. 2004). There are, however, some indications of under-reporting FV intake,



since children either do not recognize that the food they have eaten has included FV or because they have difficulties to recall correctly the amount of FV eaten (Harrington et al. 2009). If the self-reports are equally biased in all sub-groups, it is not a similar concern as when this kind of bias is found more often in certain groups, based on SES or gender, which would be of utmost importance for the interpretation of results.

## 6.4 PRACTICAL IMPLICATIONS OF THE FINDINGS

Research findings are not easily adjusted to every day practices whether on an individual or societal level. Still, as a result of Studies I–IV, some practical implications can also be made. One thing which must be stressed is that even though gender and SES differences in FV intake exist already at the age of 11-years, inadequate FV intake is by no means characteristic for only some sub-groups. This fact should be of interest on a national level as well: it has been calculated that worldwide the burden of deaths attributable to diets low in FV intake has increased from 5.1 million in the year 1990 to 6.7 million in 2010 (Lim et al. 2013). This indicates that on a societal level, responsibility has to be taken by acknowledging FV intake as an important issue and prevention as a cheaper act than treating diseases related to poor diet decades later. Therefore, change might be needed in the policies throughout maternity clinics, preschools, primary schools, vocational schools and work place canteens.

Although low FV intake is also a problem in the general population, special attention should be paid to children from low SES families. The planning of interventions aiming to decrease the socioeconomic gradient in FV intake requires careful consideration regarding the appropriate methods to be used and factors which are to be targeted. Most interventions going through post-hoc sub-group analyses were reported to be equally efficient among all children regardless of their socioeconomic background (Lien et al. 2014). An exception was a program where free, healthy breakfast was provided at school, which increased breakfast eating especially among children with lower parental SES (Lien et al. 2014). As shown in Study I, availability of FV at home seems to be one crucial factor explaining low FV intake among children with lower PEL. In case of small children, one would therefore have to target parents, who are responsible for the availability of FV. Somewhat older schoolchildren could benefit from an increase in their self-efficacy to demand for a larger variety of FV and preparation skills for FV which might already be available, but not

accessible, for them. Adolescents are less likely than adults to be very interested in the long term health benefits of FV but they might still continue to eat FV because they like the taste of FV, are used to eating FV, perceive FV to help to keep them fit and if consuming FV could be saved from getting categorized as uncool (Stevenson et al. 2007).

Liking vegetables is one of the most important predictors of vegetable intake but it seems that previous vegetable intake is also one of the most important predictors of liking vegetables. Some evidence exists that eating more FV can increase liking for FV more than liking FV increases FV intake (Tak et al. 2008). Therefore, programs which aim to increase FV intake should strive for increasing liking for vegetables as well. To increase liking and intake of vegetables, compared to fruits, is more challenging, as was shown in Study IV. This indicates that interventions aiming to increase vegetable intake might require more effort and careful reconsideration of the applied techniques. Increasing the implementation level of the intervention is partly a question of resources. Therefore, including FV promotion in the school curriculum in order to have long-lasting effects would be one promising option. Providing FV at school at lunch and in special pauses can be beneficial solely therefore that there is an ongoing exposure to FV, which has been found to be one of the most important prerequisites needed for improvements in FV intake (Knai et al. 2006). In Finland, where vegetables are included in the free school lunch served every school day, most children also eat vegetables daily but the mean intake has been reported to be only approximately hundred grams per day (Lynch et al. 2014). It has been noted that providing fruits at school for free increased fruit intake among school-children in Norway more than among those children whose parents had to pay for the fruits at school (Bere et al. 2005). As shown in Study I, fruit intake frequency was the lowest among Finnish children, thus an initiation of a similar kind of a non-cost fruit provision in Finnish schools could be beneficial as well.

It can be argued that in order to increase children's FV intake, it is insufficient to improve the availability, but FV intake should also be made more pleasurable and free from barriers. It seems that some improvements in school lunch could also be made by framing it to be more tempting for children. In Finland, for example, pupils have complained that there is inadequate time to eat the lunch due to short breaks and time spent queuing (Hoppu et al. 2010). Fulfilment of girls' wishes to have a greater variance in salads (Hoppu et al. 2010) would probably not only increase vegetable intake among girls. More attention must be paid to increasing liking for vegetables and the preferences for a variety of

vegetables, especially among boys. Liking fruits appears not to be a similar problem since children reported liking them more than vegetables in all of the examined countries in Study I. Therefore, it is probable that children would also be more likely to increase their fruit intake if the availability increases, as was noted in Study IV. An advantage of school-based interventions is that they can reach a vast group of children with different kinds of backgrounds. School-based interventions can have a positive effect by assuring that children's social environment outside the home environment supports FV intake. The importance of descriptive norms in relation to friends was shown in this study to be as important as descriptive norms in relation to parents. This was the case among 11-year-olds and it is probable that the importance of friends, in relation to the impact of parents, will increase as children grow older. This has implications which can be directly adapted to the planning of the eating occasions in the school.

As shown in the present study, the associates of FV intake which would be crucial in explaining the SES differences (e.g. knowledge) are not necessarily the same as those generally most important predictors of FV intake (e.g. liking). This means that when interventions are planned, one should know beforehand, which are the crucial determinants to target among that certain population. Moreover, since availability of FV at home was identified to be an important factor also in explaining part of the PEL differences, the requirements of interventions should be reconsidered. How to increase availability at home through a school-based intervention, which is a common way to have impact on children's FV intake? In schools, one might have the possibility to encourage children and increase their self-efficacy to demand for more and a broader variety of FV at home. It can be, however, argued that increase in FV availability at home might need a change in knowledge, attitudes, motivation and finances of the parents. The change in such parental factors, which can be positioned as determinants of behaviour also in the COM-B model (Michie et al. 2011), might be out of the scope of a school-based intervention. Therefore, the effect of a school-based intervention might not be strong enough to yield in a change in FV intake at home. This was shown to be the case in the Food Dudes project, a school-based intervention which increased FV intake at school, but failed to increase FV intake at home in the short or long term (Taylor et al. 2013). There is, however, evidence that those school-based interventions which have been successful in including the parents or the community have been successful in increasing FV intake among children (Knai et al. 2006). The noted importance of including several contributors is in accordance with the knowledge gained from the intervention studies conducted among adult population which

generally have yielded only low to modest increases in FV intake (Rekhy and McConchie 2014). Those intervention aspects that have shown to be prerequisites for improvements in FV intake among adults have been identified: collaboration between providers, retail, government and quasi-governmental organizations (Rekhy and McConchie 2014). The abovementioned results support the notation that interventions and campaigns should be implemented at several levels and include as many aspects of children's social sphere as possible. More effort may still need to be put into reaching and evolving low SES parents, which has been found to be problematic, albeit some suggestions for improvements have been made (Pescud et al. 2015).

To achieve a change in FV intake on an individual level does not mean that only the individual level determinants should be targeted. To satisfy the prerequisites for a healthy diet, adjustments on a communal and national level also need to be implemented: high quality FV should be available everywhere for a price which is reasonable also for low income groups. The important role of home FV availability in explaining PEL differences in children's FV intake in Study I can be interpreted in the light of the Finnish study that reported less-educated adults to value lower price of FV more than higher educated ones did (Kontinen et al. 2013). The importance of low price can be an individual value, which does not implicate financial difficulties, but it can also be due to the fact that people with lower educational level less frequently have high income when compared to those with higher income (Lallukka et al. 2010). As shown in a Finnish study, adults similarly in each educational level group had higher FV intake when they also had a higher income level (Lallukka et al. 2010). The low price of nutritionally poor food and products and relatively high price of FV is a result of political decisions about taxing and subsidies which might have to be reconsidered. Hence, if the problem of combining high availability and low price has been solved for junk food, with adjustments the same can be achieved for healthier options as well.

When considering the most fundamental prerequisite for FV intake, one has to deal with the availability of FV, and inequalities in its distribution, also on a global level. One rising problem is that the supply (production, export and import counted together) of FV in many low income countries would be insufficient to satisfy the adequate FV intake of their own population (Siegel et al. 2014). It is, however, not solely a question of wealth, since the FV supply is insufficient also in countries such as the United States due to channelling the largest agricultural subsidies to the production of grains, meat, dairy and oil-plants (Franck et al. 2013, Jackson et al. 2009). The shortage in FV supply is

predicted to be met also in other high-income countries by the year 2025, if FV production is not increased substantially (Siegel et al. 2014). This notation stresses the importance of policies to assure the sufficiency of FV production, which is closely linked to, and dependent on, the division of resources between all agricultural production lines. Ultimately, it is also the decision made by the individuals about how they are compiling their diet. Moreover, the relevant question both on the individual and global level is, what sorts of – less healthy – foods and snacks would an increase in FV intake possibly outsource from the diet (see e.g. Bere et al. 2015, Kearney 2010, Tak et al. 2010).

## 7 CONCLUSIONS

The present doctoral thesis adds to the understanding of gender and socioeconomic differences in children's FV intake and its associates and predictors. Children from families with lower parental educational level had lower FV intake, which was partly explained by lower FV availability at home and children's poorer knowledge of the required amount of FV for a healthy diet. Availability, defined as bringing fruits to school, and knowledge were also the factors which could be positively influenced in a school-intervention and through which children's fruit intake was increased. Higher level of implementation of the intervention also increased children's liking for fruits and fruit intake. Vegetable intake could not be increased, which has been noted to be a common problem in previous interventions as well (Evans et al. 2012). Since vegetable intake and liking for vegetables are lower among boys compared to girls, we also examined the reasons behind these gender differences. It seems that girls' higher liking for vegetables can be partly explained by their previous higher vegetable intake but also by fewer perceived barriers for vegetable intake. This indicates the need for keeping the virtuous circle of liking FV and eating FV turning, but stresses that more attention should be paid at removing the perceived barriers as well. Since FV intake of 11-year-olds is affected by descriptive norms related to friends, and not only by those related to parents, interventions could benefit from taking into account the impact of the role models that children are surrounded by outside the home environment.

The present thesis concentrated on FV intake and its associates and predictors among schoolchildren, but the longitudinal and often cumulative effects of learning and keeping habits should be taken into account as well. Although ample FV intake is only one aspect of health behaviour, it is an important part of a healthy diet which is renewed – as existing or non-existing – by each one of us in everyday life. Therefore, it is not surprising that the habit of eating FV is one of the most important determinants of FV intake among the adult population, together with liking, knowledge and self-efficacy (Guillaumie et al. 2010). All of the above-mentioned factors can have their foundation moulded already in childhood, hence seeking positive changes in FV intake and its predictors among children warrants more attention. The present thesis applied information from a one-year period, during which children's liking for FV decreased, attitudes towards FV became less favourable and gender differences in liking for vegetables emerged. These kinds of changes are likely to precede the decrease in

FV intake that has been noted to take place in adolescence (Vereecken et al. 2015). These findings demonstrate that interventions might benefit from targeting younger children in order to hinder the unintended decrease in FV intake and its predictors.

Diminishing gender and SES differences in children's FV intake aims for equality: as an adult, one would not have to do one's gender by (dis)liking vegetables or demonstrate the membership of a certain SES group by sticking to an (un)healthy diet. Acknowledging everyone's freedom to compile their diet individually, the factors determining one's eating behaviour and preferences are mostly unseen due to their temporal distance. Although eating behaviour and taste preferences are a result of active conditioning in childhood (Ventura and Worobey 2013) – and can be substituted by relearning – adults often consider them to be manifestations of one's characteristics and the dietary choices become a way to express one's identity (Bisogni et al. 2002, Fischler 1988). The present study sought to reveal and discuss those factors behind gender and socioeconomic differences in FV intake, which start to take shape already in childhood. Striving for ample vegetable intake and liking for vegetables – as well as maintaining them – are aims that deserve more attention in intervention planning. Investments in several levels of society are required in order to support adequate FV intake and its prerequisites from early childhood on, especially among boys and children with a lower socioeconomic background.

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# APPENDICES

Appendix 1. Reliability of the factors associated with children's fruit and vegetable intake in Study I.

	Cronbach's $\alpha$									
	Bulgaria	Finland	Germany	Greece	Iceland	Norway	Netherlands	Portugal	Slovenia	Sweden
Availability of fruits	0.49	0.44	0.46	0.51	0.41	0.50	0.22	0.45	0.36	0.45
Facilitation to eat fruits	-	-	-	-	-	-	-	-	-	-
Liking for fruits	0.67	0.68	0.73	0.53	0.73	0.62	0.74	0.63	0.72	0.68
Self-efficacy to eat fruits	0.33	0.47	0.38	0.40	0.47	0.19	0.46	0.18	0.27	0.54
Knowledge of the recommendations	0.69	0.72	0.73	0.69	0.78	0.77	0.42	0.61	0.75	0.61
Availability of vegetables	0.51	0.63	0.55	0.50	0.56	0.54	0.36	0.57	0.50	0.50
Facilitation to eat vegetables	-	-	-	-	-	-	-	-	-	-
Liking for vegetables	0.81	0.84	0.86	0.78	0.84	0.79	0.83	0.83	0.87	0.85
Self-efficacy to eat vegetables	0.32	0.58	0.53	0.46	0.56	0.28	0.53	0.22	0.36	0.54

Appendix 2. Characteristics of the study samples in Study I.

	Total	Bulgaria	Finland	Germany	Greece	Iceland	Norway	Netherlands	Portugal	Slovenia	Sweden
Sample size	8159	963	934	785	892	702	479	577	883	1218	726
Response rate, %	72.2	82.0	83.2	60.4	91.8	67.8	51.3	55.2	90.2	80.7	58.8
Gender, girls %	50.4	54.0	47.4	48.7	51.0	51.3	50.7	52.0	47.8	51.5	49.7
Age, years	11.3	11.8	11.4	11.5	11.0	11.0	11.2	11.3	11.2	10.9	11.2
Education*, high %	40.9	59.6	48.9	18.1	37.6	57.0	57.5	29.8	10.2	36.8	57.9
Daily fruit intake %	46.5	44.3	33.0	49.9	47.3	55.8	50.4	48.5	47.3	50.7	39.8
Daily vegetable intake %	58.8	63.3	70.9	53.6	55.4	52.2	52.6	57.5	55.3	58.4	63.7

\* Parental educational level; lower-middle/higher